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Engineering and Mining Journal

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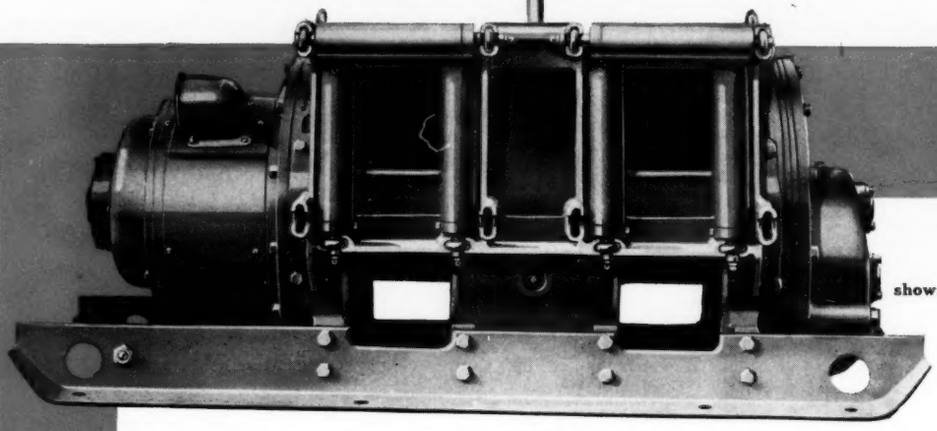
Headframe and ore bin of the Emma-Nevada shaft of Consolidated Coppermines, near Ely, Nev.

March 23, 1931

The Size 215 Electric Slusher Hoist

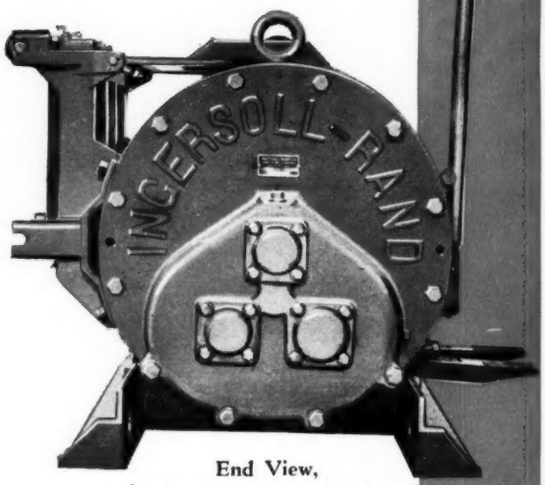


Front View,
showing cable guide roller arrangement

How Ingersoll-Rand modernized slusher hoist design

1. By starting with one main rigid housing and building from the outside in, so that all parts are fully enclosed in a compact housing; rigidly supported, and perfectly aligned.
2. By driving each of the two drums with an internal expanding clutch operated by a single safety lever control. Only one clutch can be engaged at a time.
3. By designing helical type silent gears that run in a bath of grease in an enclosed gear chamber.
4. By reducing friction losses to a minimum through the use of ball or roller-type bearings throughout. Even the cable guide rollers are provided with Timken bearings.
5. By mounting the entire hoist on strong steel skids to give a firm foundation for spragging and to aid in skidding the hoist.

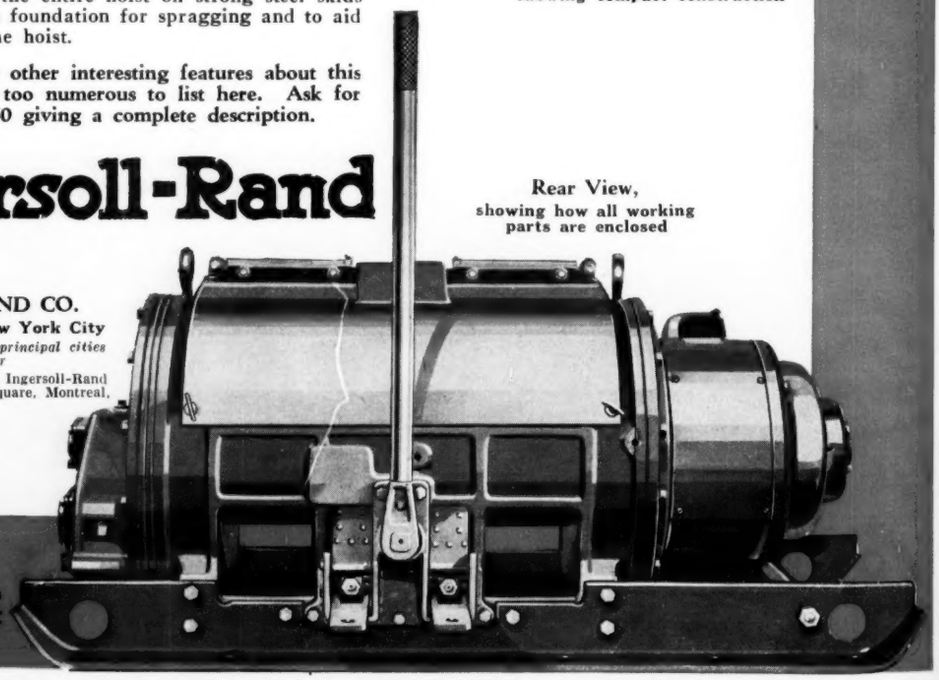
There are many other interesting features about this hoist which are too numerous to list here. Ask for our Bulletin 1860 giving a complete description.



End View,
showing compact construction

Ingersoll-Rand

Rear View,
showing how all working parts are enclosed



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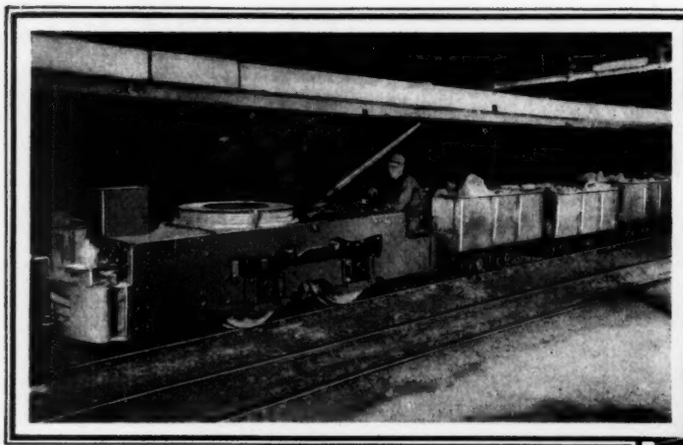
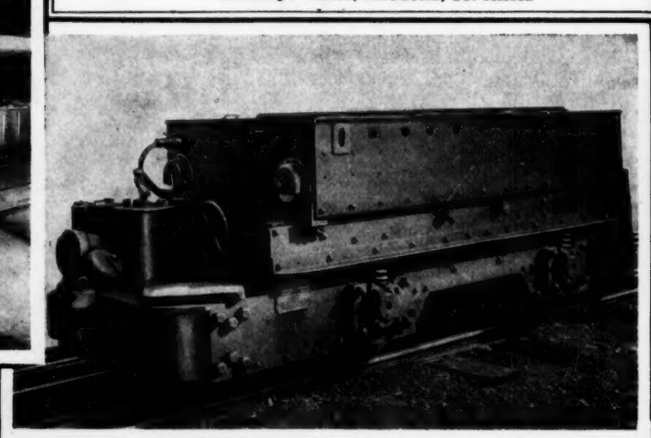
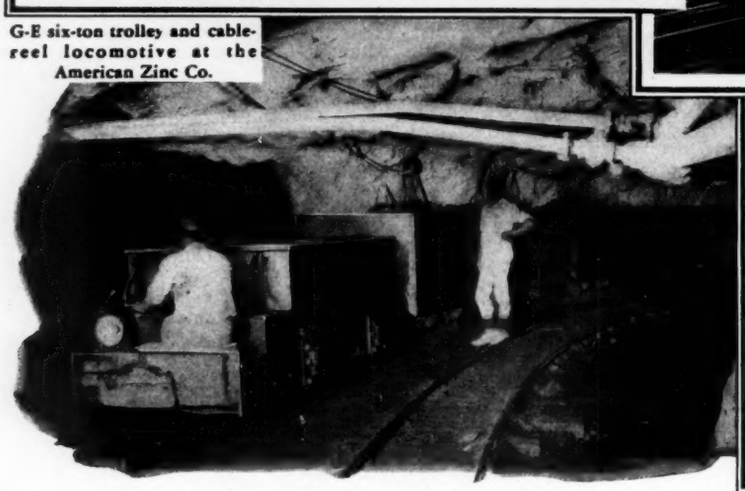


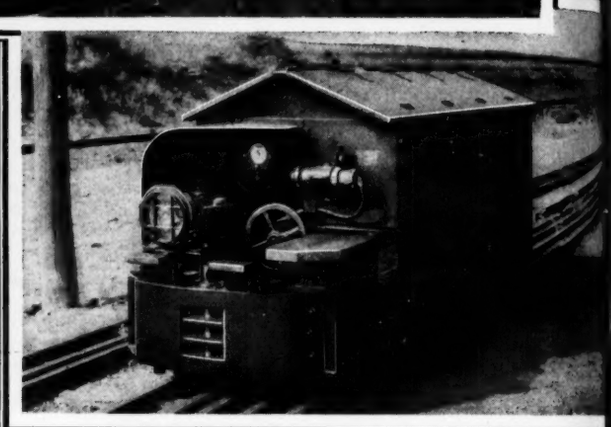
G-E six-ton battery-type locomotive at Roan Antelope Mines, Rhodesia, So. Africa



G-E six-ton trolley and cable-reel locomotive at the American Zinc Co.



G-E battery-type locomotive hauling gold ore in the Rand Mines, West Rand, So. Africa



G-E four-ton battery-type locomotive at Federal Mining & Smelting Co.

Modern locomotives on underground main lines haul more cars on faster schedule -- cut haulage costs

GENERAL

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

Engineering and Mining Journal

March 23, 1931 A. W. ALLEN, *Editor* Vol. 131—No. 6

A Platform for American Business

THE statement of underlying principles on which economic rehabilitation may be secured, to which attention was directed in a previous issue of *Engineering and Mining Journal,* calls for more than cursory interest. As was then pointed out, no proposals of this kind can hope to provide a panacea for all economic ills. But any program of this character deserves commendation if it leads to the encouragement of individual thought, the elimination of the impracticable, and the acceptance of what is obviously sound economic and social doctrine.

Engineering and Mining Journal commends to the industries it serves the recommendation that means be provided to maintain high physical and intellectual standards among the citizenry—a task the onus of which falls largely on the directors of commercial enterprise. The fine work already done by industrial associations, in the collection of statistics and in the furtherance of common aims, should spur additional effort in this direction. Planning is impossible without a knowledge of facts. Absence of a central statistical and co-operative organization usually connotes a fruitless rivalry that merely enervates the contestants, leading to unchecked production without adequate means for the stimulation of consumption.

Too much stress cannot be laid on the need for the encouragement of private initiative, and less dependence on employer or community or government. No reason exists why individualism should not be much more apparent than it is in all employee groups. Certainly, the long-term planning for American business that is recommended in the platform referred to should be practiced also by the individual. In all wise and progressive proposals for the betterment of the average citizen and his family, for provision against unemployment, incapacity, and retirement, industry as well as government must lend a sympathetic ear and a helping hand.

Syngenetic or Epigenetic— A Geologic Problem

AS A SOURCE of copper, the Kupferschiefer of Mansfeld, Germany, need cause no worry to producers of the metal elsewhere. If the world were dependent on similar deposits for its supply the price of copper would be fantastic, even though only a fraction of the present demand were to be met. But as a scientific problem for geologists, the famous German deposit has excellent possibilities. The shale, a thin bed three to eight inches thick, has a copper content of between two and three per cent, principally as bornite, chalcocite, and chalcopyrite, distributed as fine dust, as small rounded concretions, or in veins that traverse the bedding plane or parallel it. The shale lies on the Lower Permian sandstone and below the Zechstein—a bituminous limestone at the base of the Upper Permian.

In a paper by Dr. J. W. Gregory in a recent *Bulletin* of the Institution of Mining & Metallurgy, an account is given of the controversy as to the syngenetic or epigenetic origin of the Kupferschiefer. Many eminent geologists have taken part, as evidenced by a long bibliography. Doctor Gregory, after giving his views, and discussing the microscopic structure of the ore, concludes that the evidence favors syngenetic origin. Seemingly, therefore, this geologic dispute has been settled. The "syngenetics" have won. A pertinacious student, however, may reopen the subject on the basis of new evidence and disturb the complacency of the victors.

Still More Neglected Uses for Silver

PRESS ACCOUNTS describe the sweet tones of a silver bell on H.M.S. "Nelson," now in American waters. The writer of this editorial recalls the interest aroused among visitors to his alma mater when they heard a similar sound, employed to call him and his fellow students to the college chapel. No one who has listened to the dulcet tones of a silver bell, as contrasted with the harsher and less melodious sounds of one made of tin and copper, can doubt the pre-eminence of the white metal as a maker of music. Yet the opportunities for extending the use of silver for this purpose seem to have been entirely neglected. Millionaires, even mining millionaires, anxious to find an outlet for surplus funds, and not averse to the publicity that accrues from the gift unusual, especially when it appeals also to the aesthetic senses, have spent their money lavishly on almost everything but silver. Yet, could imagination be stirred to greater depths, or interest aroused more widely, than by the installation of a peal of silver bells, whose rich, mellow tones convey an impression of intrinsic quality?

A dictionary definition of "silvery" is "soft and clear in sound." Few peals of ordinary bells—even of so-called carillons or "chimes"—have escaped the caustic criticism of the listener, or the one disturbed, who com-

plains that they sound "out of tune," as most of them are. The development of a technique of making heavy silver castings may safely be left to the metallurgist, with certainty that technical problems will be solved. Where can be found the philanthropist who will pioneer in reducing thus the surplus of silver, by providing his fellows and those who come after, for time immemorial, with such "things of beauty" that will prove "a joy forever," which "will never pass into nothingness"? Many fortunes have been made from silver mines. Little of the money has been spent in purchasing the output for utilitarian and artistic purposes.

So much for the spectacular. A year or so ago we proposed that sterling-silver ware should be available in the low-price stores, believing that mass selling of small individual amounts of the metal would soon aggregate into large totals. A beginning has since been made, with sterling-silver rings, the Woolworth company being the enterprising pioneers. The advantage gained must be pressed. Let silver be used for small bells as well as for larger ones. Why should the stress and strain of modern life be supplemented by the harsh and raucous tones of the ordinary bell used to attract attention in the office or home—at the table, in the kitchen, at the telephone? A shrill and piercing sound is sometimes needed, but must almost all bells be shrill and piercing? What a selling point the manufacturer would have who could truthfully advertise a clock "with silver chimes." Imagine an organ equipped with a solo stop of silver bells! Why not an intensive campaign to educate and convince the fabricators of bells of all kinds as to the quality, appeal, and beauty of tone of silver metal, and its comparatively low price? Altar bells might well be of silver. Most of those now in use are not even silver plated. And—why not a little more silver in the collection plate? A vast majority of pastors, we dare affirm, are getting fearfully tired of so much misplaced copper and nickel.

An Optimistic View of the Future of Gold Mining

THE last eighteen months have witnessed a plethora of economic discussion that must weary even the most ardent economist. One cannot escape it. Time-worn platitudes are repeated on every side by a hundred prophetic voices—the fact that there is nothing new to say does not impede the flow of rhetoric. Of all these wordy disputations, probably none has been more repetitious than that on the world's gold supply. Only two possible truths emerge: either increasing supplies of gold are necessary for world financial stability or they are not. As the observable facts have not yet indicated clearly which postulate is true, the argument continues unabated. No tangible achievement has yet resulted from it, save possibly the calling of attention to the possibilities of gold mining as an investment. For that much, the mining industry must be grateful.

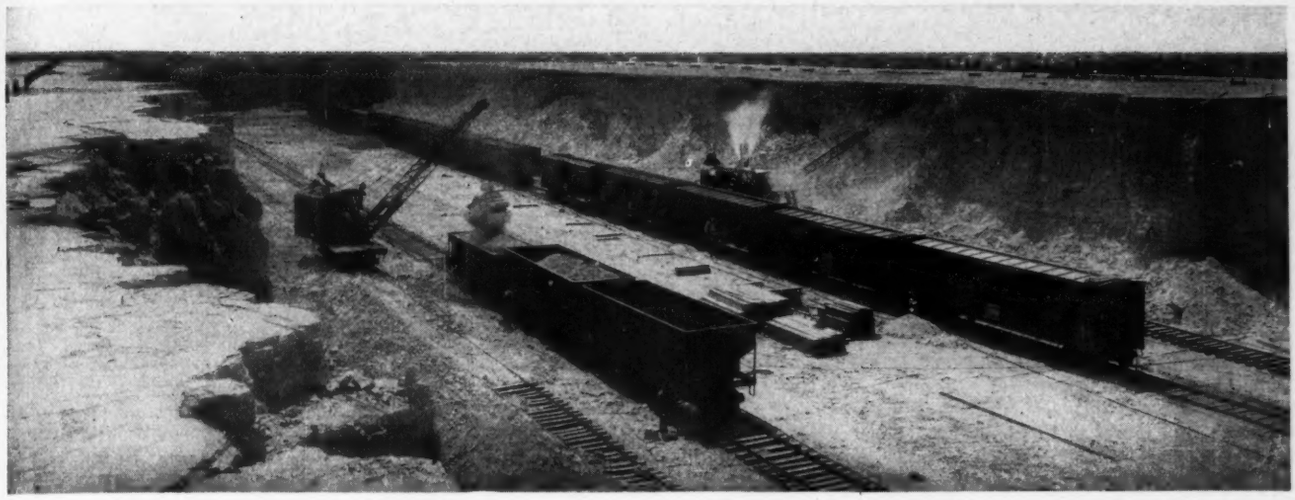
Most of the discussions of future gold production have been written from a narrow viewpoint. They have assumed that present conditions would be projected into the future, and they have therefore been unable to visualize an inviting prospect. This is true of the paper by Mr. H. A. Kursell, of American Smelting & Refining, published in these columns several months ago; of the report submitted by Mr. Joseph Kitchin to the Gold Delegation of the League of Nations; and of the paper presented by Mr. George Collins at the Gold Supply Symposium at the recent A.I.M.E. meeting in New York. All three of these reviews are able statements of the facts as now known, but they do not make much allowance for developments in the future. In this respect, the address made by Dr. L. C. Graton at the Gold Supply Symposium is strikingly different.

Doctor Graton is no exuberant optimist. He does not make extravagant claims, and he does not attempt to forecast, statistically, the future production of gold—a pitfall into which Mr. Kitchin, perhaps by compulsion, stumbled. But he does make full allowance for those factors which have played so tremendous a part in the mining industry of the past. No one will dispute that improvement in mining or metallurgical methods, by which the cost of treating gold ore would be reduced 20 or 25 per cent, would vastly increase available reserves. Doctor Graton sees the possibility of such reduction, particularly in mining costs, and past experience must be admitted to be on his side. This much is certain—if a shortage of gold actually exists, the cost of living (or, for the gold miner, the cost of labor and supplies) will certainly not increase markedly in the future. Any improvement in technique, any new labor-saving invention, will mean a reduction in gold-mining expenses, an increase in gold production.

None can gainsay the truism that eventually the gold resources of the world—even as the coal, the copper, the iron, and the other mineral resources—will be exhausted. To say that the day is far distant may be, as some alarmists insist it is, an evasion of the truth—an attempt to be cheerful even to the last gasp. But when Doctor Graton says that no indication is evident that the peak of gold production has been reached, that the future still holds promise of new mines and lower costs, *Engineering and Mining Journal* feels impelled to toss its editorial cap in the air and give three hearty cheers of assent. The gold-mining industry is innocent of declining production until proved guilty.

Mineral vs. Gangue

AN ARTICLE on the effect of grinding on flotation refers to the material that floats under ordinary conditions of application of the flotation process, or that it is desired to float, as "mineral," as contrasted with the valueless rocky part of the ore termed "gangue." However, the gangue is obviously as much a mineral or an aggregate of minerals as is the valuable part of the ore. Pirsson has written a book about the rock minerals. Moreover, the dictionary states that water is a mineral, thus complicating the situation by recording three classes of mineral in a pulp instead of two. The phraseology "valuable mineral" is cumbersome; and it may be deemed incorrect as well. "Easily floatable mineral" is even more awkward; also, it is unscientific. Will some reader coin a good word, or shall we all agree, in discussing flotation, that "mineral" means the opposite to gangue"?



Simultaneous loading from two opposing "bins" of sulphur

Mechanical Mining and Treatment of Sulphur

J. B. Nealey

THE Freeport Sulphur Company, of Freeport, Tex., has two producing properties: one at Hoskins Mound and the other at Bryanmound, Tex., about 23 miles apart. The Bryanmound deposit was disclosed while drilling for oil in 1900-1905, but not until 1913 was mining of the sulphur started. At Hoskins Mound, where mining was begun in 1923, preliminary operations included construction of 15 miles of railroad, 10 miles of shell road, and 5 miles of canals to procure an adequate supply of water.

In mining the sulphur, the Frasch method is used, water heated considerably above the melting point of sulphur being pumped through wells into the subterranean strata, and the liquefied sulphur being forced to the surface with compressed air. In this method the largest cost factor is that of securing, treating, heating, and distributing water, enormous quantities of which are necessary. Cheap fuel gas, available at the Freeport properties, helps to keep this expense at a minimum.

The power and water-heating plant at the Hoskins Mound property, which comprises twelve steam boilers of 700 hp. each, operates continuously throughout the year and has an efficiency of 80 per cent. Oil fuel was tried and discarded, gas being adopted when the aforesaid high efficiency was obtained with it. These boilers furnish steam for three turbo-generators, which, in turn, supply electric power for motors operating drilling equipment and some of the pumps in the field. The rest of the steam is used in engines that operate 36 pumps in the plant, as well as eight air compressors. Exhaust steam is piped to eight water heaters.

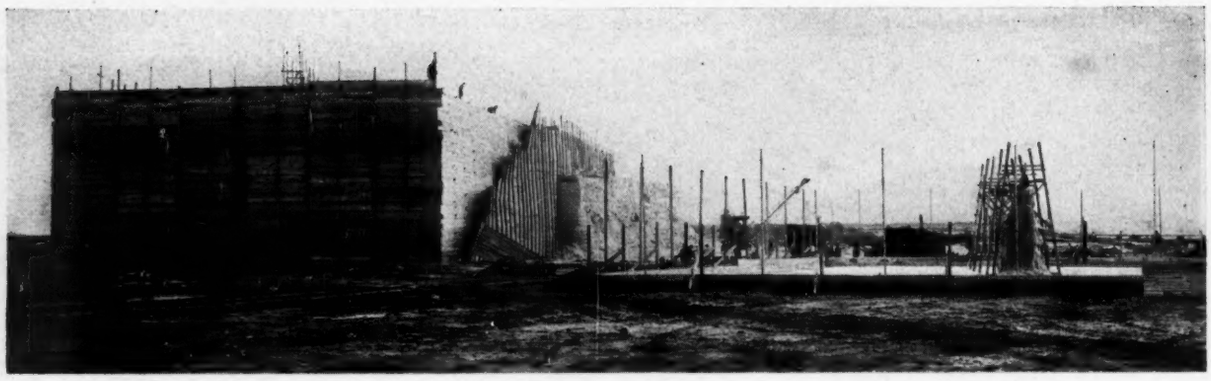
Water is pumped from the canals into two reservoirs of 50,000,000-gal. capacity each, whence it runs by gravity to the boilers. Approximately 6,000 lb. of lime is used daily to soften this water, which is used at the rate of 6,000,000 gal. per day. At the power plant, eighteen cold-water pumps lift water into the heaters, where it meets live steam and is heated to 340 deg. F., and sixteen other pumps force the hot water through pipe lines to the various wells in the field, and then underground to the sulphur-bearing strata. The distance this hot water is carried ranges from 2,000 to 5,000 ft.

A well consists of an 8-in. casing containing a 4-in. pipe, within which is a 1¼-in. pipe. Hot water is pumped down the casing, and the compressed air is forced through the smallest pipe, the sulphur rising through the 4-in. pipe. The hot water flows first, and, when enough liquefied sulphur has been accumulated at the bottom, it is turned off and the air turned on, which causes the sulphur to rise. The specific gravity of sulphur being twice that of water, it comes to the surface in the pure state and is pumped through a 4-in. line, equipped with a 1-in. gut pipe, to a relay station that receives and measures the output of each of the wells.

The liquid sulphur is then pumped through a 6-in. steam-heated line to a storage bin 182 ft. wide, 600 to 1,200 ft. long, and 30 to 50 ft. high. The walls are of 2x12-in. plank sheathing, 14-ft. long, nailed to 4x4-in. studs spaced at 14-ft. centers. Additional 2x4-in. studs are placed midway between the 4x4 in. studs. The plank sheathing is placed on the inside, next the sulphur; joints between the planks are covered with ¼x4-in. batting. The studs are sunk 2 ft. in the ground. But little bracing is necessary. The walls are carried upward as required, never more than about 5 ft. above the top of the sulphur, permitting workmen to reach the top course while standing on hardened sulphur.

The 6-in. discharge line is carried on a steel runway 3 ft. wide, which is constructed of 1¼-in. pipe made up in standard removable sections 25 ft. long. It is supported on a trestle, which is erected on the center line of the bin. Trestle legs are round timbers, up to 60 ft. in length, sunk 7 ft. in the ground. They are placed 6 ft. apart at the bottom, and are battered 6 in. in their total height. Caps consist of two 2x12-in. planks, one bolted to each side of the bent. Sway bracing is 2x12-in. plank. No longitudinal bracing is necessary, as the legs are soon supported by the hardened sulphur. Bents are placed on 25-ft. centers to accommodate the runway sections.

Sulphur is pumped to the bins from the central relay station, a distance of



Removing forms from "bin" at the left, and building forms of bin at the right

about 1,400 ft., by means of Layne & Bowler four-stage vertical centrifugal pumps, through a 6-in. asbestos-covered line, in the center of which passes a 2-in. steam line, with steam traps at various points to remove condensation and maintain the sulphur at approximately 285 deg. F. Pressure at the relay station is 105 lb. per square inch. Pumping is not continuous, the sulphur being pumped to the bins after the relay station pit has become filled. At one end of the bin the 6-in. line rises vertically to the level of the runway. Within the bin, 1¼-in. discharge openings are provided at intervals of about 100 ft. Sulphur that remains on the site, following the removal of the last previous bin, forms the floor for the succeeding bin.

At the temperature at which it flows into the bin, the color of the sulphur is a bright orange; as it begins to solidify, it becomes brown, and finally upon thorough cooling, it changes to a bright yellow. When being discharged into the bin through the several discharge openings, the liquid sulphur spreads evenly over the entire surface in a thin layer. Within a few moments after the batch from the relay station has been pumped, it has completely solidified. The sulphur forms in a huge block, and the purpose of the side walls is merely to shape the block and retain the melted sulphur that spreads over the surface, until it becomes solid.

Almost immediately after the bin has reached full height and pumping has been discontinued, the side walls may be torn down. This is accomplished by first cutting the 4x4-in. braces at the ground level and then using a Fordson tractor and rope, with a hook attached to the top of the wall. The wall is removed easily from top to bottom, in sections of from 28 ft. to 70 ft. along the face. The lumber is cleaned up and salvaged for further use in field operations.

Two methods of drilling and blasting are employed; namely, "snake holing," or shooting at the bottom, and vertical drilling. The first method is generally used in bins 30 ft. or less in height. The arrangement of the holes is shown in Fig. 1. Twenty holes, ten at the top and ten at the bottom, usually constitute a round, as shooting a greater number produces too great a seismic effect, endangering near-by plant foundations and fixtures. The upper holes are each charged with five sticks (6¼ lb.) of Du Pont F White Dope dynamite and the lower holes with six sticks (7½ lb.) of the same dynamite. Electric firing is employed, a No. 6 electric cap in each hole being connected in parallel to a 110-volt lighting circuit.

Six men and an inspector constitute a drill crew. Assisted by a crane, the members of a crew pick and bar down any loose sulphur along the face and clean the bottom to make the face accessible. This operation, for a twenty-hole round, takes about half an hour. When the face has been prepared, one man does the requisite laying out of the holes and any picking necessary to assist in starting the hole. Two men then drill the first 5 ft. of each hole, using a 6-ft. drill, two others completing it to 10 ft. with an 11-ft. drill. The sixth man cleans the holes thoroughly. The holes shown in Fig. 1 are in the same vertical plane, each pair being spaced 6 ft. apart longitudinally. The hardness of the sulphur varies. A 10-ft. hole is drilled in an average time of about three minutes, the six men with two drills completing a twenty-hole round in about half an hour.

Drilling is done with Cincinnati Electric Type G.A. machines, equipped with ¾-hp. motors, operating on a 110-volt 60-cycle, single-phase lighting circuit. In operation the speed of rotation varies from 60 to 100 r.p.m. A ½-in. pipe screwed into each side of the machine serves as a handle. Augers are 2 in. in diameter and are made with a V bit. Sharpening and steel consumption, owing to the relative softness of the sulphur, are negligible items.

Charging is ordinarily performed by the drill crew, charging and tamping of a twenty-hole round taking about 30

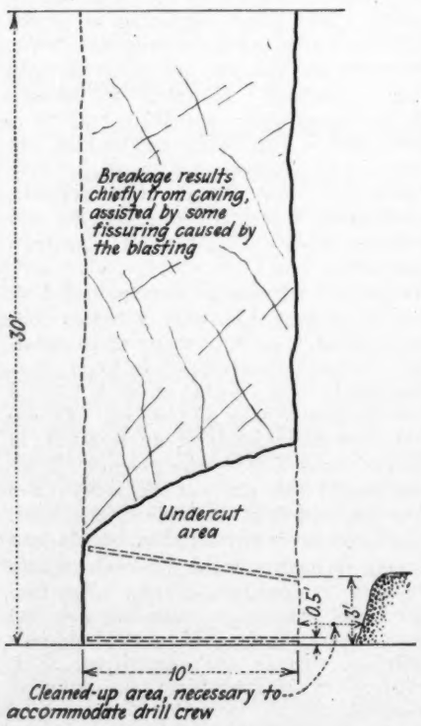


Fig. 1—"Snake-hole" drill round at end of 30-ft. bin

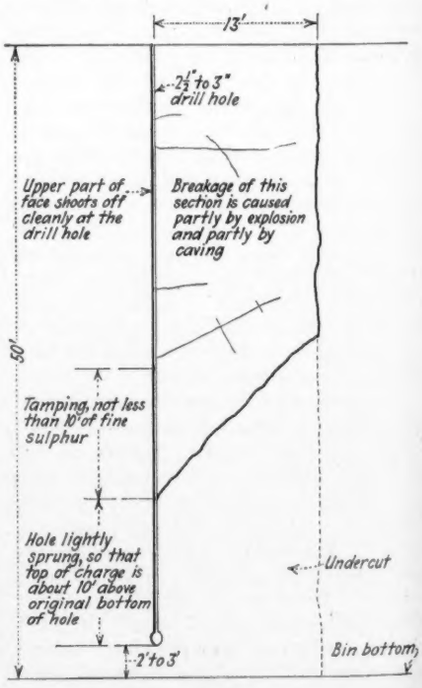

13'
2½" to 3" drill hole
Upper part of face shoots off cleanly at the drill hole
Breakage of this section is caused partly by explosion and partly by caving
50'
Tamping, not less than 10' of fine sulphur
Hole lightly sprung, so that top of charge is about 10' above original bottom of hole
Undercut
2' to 3'
Bin bottom

Fig. 2—Vertical drill round at end of 50-ft. bin

minutes. Each hole is tamped with seven 2-in. paper tamping bags filled with fine sulphur. Little over-break occurs. Du Pont F White Dope dynamite of 10 per cent strength, in 2x8-in. cartridges, is generally used, which weighs about 1¼ lb. per stick. It is bought in red wrappers that make unexploded sticks more readily visible, this color being in vivid contrast to the yellow sulphur. Misfires are rare. Based on a 30-ft. height of bin, the yield per pound of explosive is about seven tons.

When bins are carried to heights greater than 30 ft., the danger that material may fall from the face increases. To overcome this, and also to effect economies in operation, vertical holes are drilled from the top of the bin to within about two feet of the bottom by means of a miniature rotary rig. The outfit employed is equipped to drill 2½-in. and 3-in. diameter holes with a fish-tail bit. Drill stems are made in 5-ft. sections. A 3-hp. motor drive is connected to the 110-volt lighting circuit. Water is available at sufficient pressure to wash out the cuttings. This outfit drills an average of 400 ft. in an eight-hour shift. The rig is operated by three men, an inspector giving part of his time to supervising the work of the crew.

Spacing and firing details are shown in Fig. 2. Usually, a maximum of five holes, spaced 15 ft. apart longitudinally, are shot in a round. Each hole is charged with 50 lb. of Du Pont F White Dope dynamite, and two No. 6 electric caps are used per hole, connected in parallel to a 110-volt lighting circuit. Based on a bin 50 ft. high, the yield per pound of explosives is about 9.5 tons. The economical limit between "snake holing" and vertical holes lies between 30-ft. bins and 40-ft. bins. Vertical drilling has the added advantages of greater safety and non-interference with loading operations.

The general theory of the blasting methods employed is apparent from the sketches. Use of a "quick" explosive is out of the question, owing to the friability of sulphur. The execution desired is the production of a maximum amount of lumps of about 12-in. diameter, with a minimum of fines. Secondary breaking is not difficult, but it impedes operation. Large chunks are blockholed.

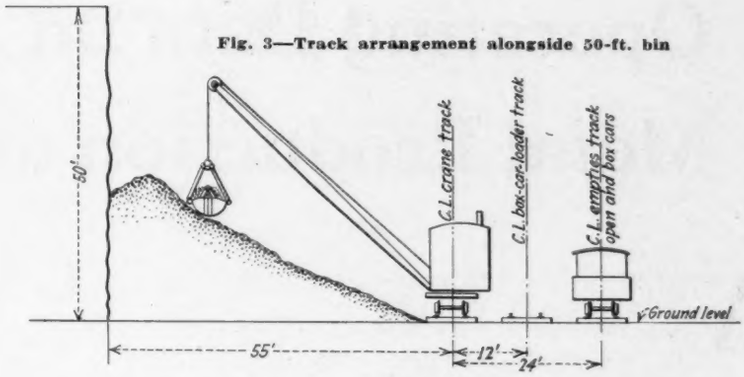


Fig. 3—Track arrangement alongside 50-ft. bin

The drill crews are under an inspector who is especially responsible for electrical testing of caps, electrical connections, and general safety of the blasting operations. The company is justly proud of a record of eighteen years' operation without a single accident caused by explosives.

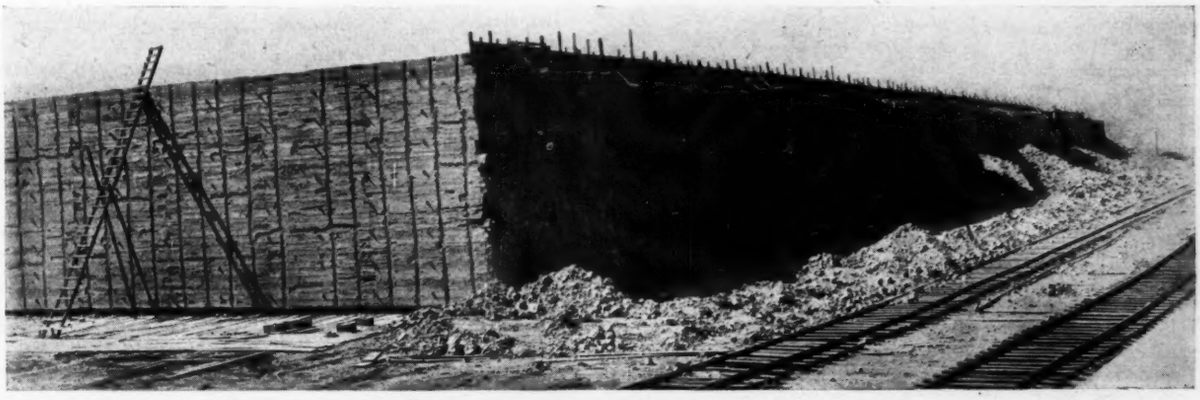
Parallel with each long face of both sides of a bin, three tracks are laid as shown in Fig. 3. In general, the center line of the crane track should be at a distance from the face equal to the height of the bin. The box-car loader track is omitted when no closed cars are to be loaded from that side. Tracks are shifted when sufficient broken sulphur is no longer within reach of the crane. An empty train may be placed in the length of the bin, the crane moving from car to car, thus requiring only one spotting of a train during a shift.

As cranes and box-car loader are mounted on standard railway trucks, all tracks are standard gage. Standard practice is followed in track work. Rails are 80 lb., A.S.C.E. section, and are laid directly on 6x8-in. x 8-ft. ties. Ties of untreated sawn gum and creosoted pine are used. Within the area of the bins, the tracks are ballasted with broken sulphur, as other materials would cause contamination.

Brownhoist Model No. 5, 25-ton locomotive cranes are used for loading the sulphur into open cars. These cranes are steam driven, using oil for fuel. They are equipped with 46-ft. lattice booms, work at 38-ft. radius, with 54-cu.ft. Brownhoist link-type grab buckets. Average amount loaded per crane per operating hour into open cars is 209 gross tons. Equipment used for open-car loading is chiefly 50-ton steel-hopper cars, which are used to transport the sulphur 21 miles to the Freeport loading dock, where it is loaded aboard steamers.

For box-car loading, an Ottumwa scraper-line portable loader is used, which works from car to car on a track between the crane track and car spotting track. This unit is mounted on a standard-gage truck, which also supports over the loader a 4-cu.yd. aluminum receiving hopper. Sulphur is delivered by the cranes to the receiving hopper, where it is conveyed by several conveyors to the inside of the car. Average tons loaded into box cars per operating hour is 140 gross tons per loader. Yard switching is done by the Missouri Pacific Railway, the tracks of which company extend to the sulphur bin track system.

The Freeport Sulphur Company maintains a Type S 15-75, four-section Fairbanks-Morse track scales for weighing all incoming cars and outgoing loaded cars. This scale is operated under the supervision of the Western Weighing and Inspection Bureau and receives periodically the test car service that is afforded by the Missouri Pacific Railway system.



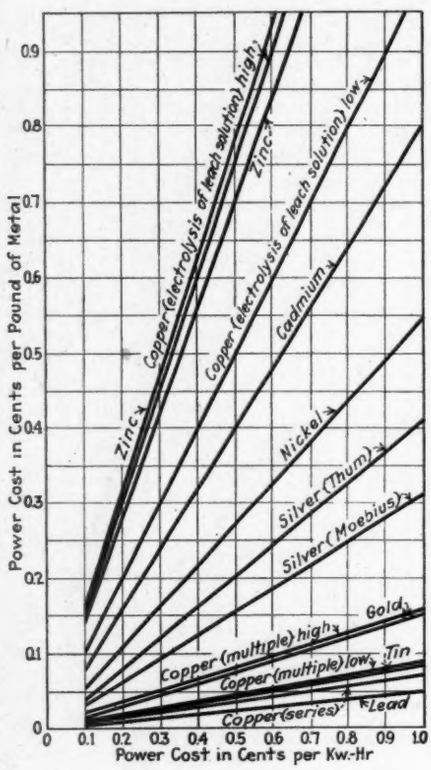
A "bin" of sulphur, with forms removed

Operating Data on Electrolytic Metal Production and Refining

C. L. Mantell

Consulting Engineer,
New York

ABOUT 92 per cent of the copper, 25 per cent of the zinc, 8 per cent of the lead, 75 per cent of the cadmium, 83 per cent of the silver, and probably the entire output of bismuth in the United States are the



Electrolytic Refining of Lead

	Consolidated Mining and Smelting, Trail, B. C.	U. S. S. Lead Refinery, East Chicago, Ind.	American Smelting & Refining, Omaha, Neb.
Electrolyte:			
Per cent Pb	7—9	10	10
Total H_2SiF_6	12—13	12	15
Temperature, deg. C.	35—40	35—38	38
Circulation, gallons per minute	4	3—4	5
Circulation apparatus	Copper plunger pumps	Copper centrifugal pumps	Copper centrifugal pumps
Current:			
Amperes per square foot cathode	17½	17—18	16
Voltage per cell	0.4—0.6	0.35—0.5	0.55
Current, kilowatts per generator	5,000 amps. at 200 volts	5,400—5,800 amps. at 100—115 volts	2,600 amps. at 25 v. 5,200 amps. at 50 v.
Anodes:			
Composition	Pb 99%, Sb 0.7—0.9%		Pb 98%
Length, width, thickness	2′ 6⅛″x2′ 2½″x1⅛″	3′x2′x1¼″—¼″	2′ 4″x1′ 10″x1½″
Weight, pounds	390	460	375
Mode of suspension	Cast lugs	Cast lugs	Cast lugs
Life, days	8		10
Per cent scrap	25—30		35
Cathodes:			
Size starting sheet l.xw.xt	38½″x26½″x$\frac{1}{32}$″	37″x25″x⅛″	29½″x23″x⅛″
Weight, pounds	10—12	10	9
Mode of suspension	Wrapped	3 strips	Loop
Life, days	4		5
Weight, pounds	150		130
Cells:			
Length, width, depth	876 at 8′ 9″x2′ 6½″x3′ 8″ / 240 at 7′ 4½″x2′ 6½″x3′ 8″	11′ 6″x2′ 6″x4′	11′ 0″x2′ 2″x3′ 0″
Number of anodes, cathodes	24, 25—20, 21	28, 29	26, 27
Electric connection	Great Falls type	Walker	Slot
Material of construction	Cement, concrete, and asphalt	Wood, pitch coated	Concrete, asphalt lined
Anode mud:			
Composition	Pb 10—14%, Sb 40—45%, Cu 2%, As 0.5—3%, Sn, trace (a)	Ag 15 oz./ton, Au 0.7 oz./ton, Pb 10—15%, Sb 35—40%, As 5—8%, Bi 5—8%, Sn 1—1.5%, Cu 2—4%, Fe 0.1—0.2%, Se 0.20%, Te 1—2%	Ag 60 oz./ton, Pb 4.5%, Sb 6%, As 1—1½%, H_2O 25%
Removed after (?) days			11

(a) Au and Ag proportional to bullion content.

Electrolytic Production of Cadmium

	Kennett	Anaconda
Raw material	Baghouse fume from copper furnaces	Precipitate from zinc dust purification of zinc electrolyte
Electrolyte:		
Grams cadmium per liter	8	100—120
Grams zinc per liter		80
Temperature, deg. C.		35
Feed to cells		Individual
Spent electrolyte:		
Grams H_2SO_4 per liter		70—80
Current per cell, amperes	1,200	1,110
Current density, amperes per square foot	15	4.25
Voltage per cell	4	2.6
Current efficiency	85%	80—90%
Kilowatt-hours d.c. per pound	1.27	0.82
Anodes:		
Composition	Lead	Lead
Size	Semicircular, slightly larger than 4′ diam.	45″x24½″x$\frac{3}{16}$″
Mode of suspension	From side of cell	Cast around conductor
Anode-cathode spacing	2½″	3½″
Cathodes:		
Type	Rotating	Stationary
Size	4′ diam.x$\frac{1}{16}$″ thick	45″x24″x$\frac{3}{16}$″
Composition	Aluminum	Aluminum
Mode of suspension		riveted to conductor
Removed		24 hours
Weight in pounds	113 lb./cell/day	100 lb.
Tanks:		
Size	Semicircular, lead-lined, 200 gal.	
Material of construction	Wood, lead-lined	Wood, lead-lined
Number anodes and cathodes	11, 9	27, 26

Electrolytic Refining of Gold

	Wohlwill, D. C.	Wohlwill, A. C.—D. C
Electrolyte:		
Per cent gold	7–8	7–8
Per cent HCl	10+	10+
Specific gravity	1.30	1.30
Temperature, deg. C.	70	70
Circulation	Air lift	Air lift
Voltage	1.3 to 1.6	0.8 to 1.1
Cathodes:		
Material	Rolled-gold sheet	Rolled-gold sheet
Purity or fineness	999.75	999.5
Current density	110 to 120 amp./sq. ft.	D.C. 120 to 160 amp./sq. ft. A.C. 120 to 250 amp./sq. ft.
Cells:		
Material	Porcelain or chemical stoneware	Porcelain or chemical stoneware
Anodes:		
Composition	95 to 98% Au, 1 to 4% Ag, Pt. Pd, rare metals	90+% Au, 6+% Ag
Current density	110 to 120 amp./sq. ft.	
Anode mud	20 to 30% Au, AgCl, $PbSO_4$, trace of base metals and rare metals	1% Au, 95% AgCl

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Electrolytic Refining of Copper

	American Smelting & Refining, Maurer, N. J.	American Smelting & Refining, Baltimore, Md.	American Smelting & Refining, Tacoma, Wash.	Anaconda Copper, Great Falls, Mont.
Electrolyte: Sp. g.	1.28	1.25	1.240	1.275
Per cent copper	3.3 (42 grams/liter)	3.5 (43 grams/liter)	3.3 (40.9 grams/liter)	4.2 (53 grams/liter)
Per cent free H_2SO_4	17 (217 grams/liter)	14.5 (181 grams/liter)	15.0 (186.0 grams/liter)	21.0 (220 grams/liter)
Temperature, deg. C.	57	55	57	60 in, 55 out
Circulation, gallons per minute	3	4.5	4.5–5.0	6
Circulation apparatus	Vertical centrifugal pumps	Vertical centrifugal pumps	Vertical centrifugal pumps	Air lifts
Current:				
Amperes per square foot cathode	18	19	20	25–26.4
Voltage per cell	0.18	0.2	0.3	0.4
Current, kilowatts per generator	1,250	760	300 { 150 volts, 2,000 amp. 750 { 150 volts, 5,000 amp. 1,110 { 185–volts, 6,000 amp.	4–624 { 200–240 volts, 3,000–2,600 amp.
Current efficiency	90%	89%	95%	94%
Kilowatt-hours per pound copper	0.09	0.11	0.12	0.166
Pounds copper per kilowatt-day, d.c.	266	209	200	145
Anodes: Composition	Cu 99.5%, Au 0.7 oz/ton, Ag 40–82 oz./ton. Pb 0.02%, Sb 0.006%, As 0.0076%, Se 0.009%, Ni 0.038%	Cu 99.2%. Au 1.0 oz/ton, Ag 90 oz./ton, Pb 0.03%, Ni 0.08%, As 0.06%, Sb 0.05%, Se 0.06%, Te 0.07%	Cu 99.2%. Au 1.0–2.0 oz./ton, Ag 40–100 oz./-ton, Pb 0.03%, Fe 0.05%, Ni 0.20%, As 0.04%, Sb 0.03%	Cu 99.3%, Au 0.03 oz./ton, Ag 67 oz./ton. Sb 0.03%, As 0.085%, Fe 0.03%, Te 0.07%, Ni 0.008%
Length. width, thickness	35⅛"x36"x1¾"	40"x35"x1¼"	37"x28"x1½"	36½"x28"x2"
Weight, pounds	650	775	510	630
Mode of suspension	Cast lugs	Cast lugs	Cast lugs	Cast lugs
Life, days	30	31	24	25 to 26
Per cent scrap	15	16	15	11.3
Cathodes:				
Size starting sheet, l.xw.xt.	37½"x36½"x0.025"	41"x37½"	38"x29"	38"x29"
Weight, pounds	11	13	10.0	7
Mode of suspension	Large central loop	Large central loop	2 small side-loops	2 small side-loops
Replaced after (?) days	15	15½	8	6
Weight, pounds	270	330	145	135
Manipulation of electrodes	Overhead cranes	Overhead cranes	Overhead cranes	Overhead cranes
Deposition cells:				
Length, width, depth	11'6"x3'5½"x3'6½"	13'4½"x3'7"x4'	8'3"x2'9"x3'8" 12'4"x2'9"x3'10" 14'8"x2'9"x3'10"	10'3"x2'10"x3'9"
Number of anodes, cathodes	29, 30	38, 38	22, 23–35, 36–42, 43	25, 26
Electric connection	Special single contact	Single contact	Whitehead single contact	
Ampere per square inch, cross-section	476	400	500	1,000
Anode mud:				
Per cent of anode	0.4	1.5	0.5	0.42
Composition	Au 175 oz./ton, Ag 10,000 oz./ton, Cu 19%, Pb 5%	Au 80 oz./ton, Ag 7,000 oz./ton, Cu 18%	Au 200 oz./ton, Ag 10,000 oz./ton, Cu 16.0%, Pb 5.0%	Au 50 oz./ton, Ag 13,300 oz./ton, Cu 1.5%, Pb 1.0%
Removed after (?) days	30	31	24	24

	Raritan Copper Works, Perth Amboy, N. J.	U. S. Metals Refining, Carteret, N. J.	Nichols Copper, Laurel Hill, N. Y.	Nichols Copper, El Paso, Tex.
Electrolyte: Sp. g.	1.28	1.250		
Per cent copper	3.5 (45 grams/liter)	3 (37.50 grams/liter)	2.8	3
Per cent free H_2SO_4	16.0 (205 grams/liter)	15.5 (193.75 grams/liter)	18	17
Temperature, deg. C.	55	60	50	57
Circulation, gallons per minute	4	4	4	3–5
Circulation apparatus	Vertical centrifugal pumps	Vertical centrifugal pumps	Vertical centrifugal pumps	Vertical centrifugal pumps
Current:				
Amperes per square foot cathode	18	17.5	20–24	15
Voltage per cell	0.25	0.25	16–18	
Current, kilowatts per generator	720 { 190 volts, 8,200 amp.	1,530 { 133 volts, 11,500 amp.	300 volts, 1,200 amp.	3–1500, 90–150 volt
Current efficiency	92–95%	96%	70–73%	
Kilowatt-hours per pound copper	0.111	0.097	0.074	
Pounds copper per kilowatt-day, d.c.	216	247	324	
Anodes: Composition	Cu 99–99.5%	Cu 98.92%, Au 1 oz./ton, Ag 60–80./ton, Ni 0.25%, Sb 0.11%, Pb 0.18%, Fe 0.03%, As 0.05%	Cu 99.3%, Au 0.5 oz./ton, Ag 25.00 oz./ton, Pb 0.06%, Sb 0.019%, As 0.06%, Se 0.05%, Ni 0.14%	Cu 99.57%, Au 0.81 oz./ton, Ag 25.5 oz./ton, As 0.0032%, Sb 0.0033%, Pb 0.021%, Ni & Co 0.03%, Se & Te 0.028%, Fe 0.004%, O₂ 0.250%, S 0.0026%
Length, width, thickness	36"x28"x1½"	36"x36"x1¼"	56½"x12"x¾"	36"x36"
Weight, pounds	525	500	104	700
Mode of suspension	Cast lugs	Cast lugs	Punched lugs	Cast lugs
Life, days	30	23	21	
Per cent scrap	10–12	14	6–7	13.5
Cathodes:				
Size starting sheet, l.xw.xt.	39"x30"x0.023"	37"x38"		
Weight, pounds	8	10.5		
Mode of suspension	2 small side-loops	2 small side-loops	No suspension—deposited on —anode; series system	Large central loop
Replaced after (?) days	10	11½	Not removed	
Weight, pounds	160	225	94–99	
Manipulation of electrodes	Overhead cranes	Overhead cranes		Overhead cranes
Deposition cells:				
Length, width, depth	10' x2' 10"x4'	11'x3' 6"x3' 8½"	16' 6"x5' 5"x5' 1"	13' 2"x3' 6½"x3' 9"
Number of anodes, cathodes	28, 29	37, 38	510 anodes, plus 5 heavy plates and 5 skins	33, 34
Electric connection	Walker	Walker	No connection except between cells	Whitehead single contact
Ampere per square inch, cross-section	700	900		400
Anode mud:				
Per cent of anode	0.6	1.3	0.8	
Composition	Ag 25%, Cu 20%	Au 80 oz./ton, Ag 5,000 oz./ton, Cu 20%, Pb 17%, Sb 8%	Au 150 oz./ton, Ag 7,500 oz./ton	
Removed after (?) days	30	23	At end of run	

products of the electrolytic cell. Of the world's nickel production more than 30 per cent is refined electrolytically. Metals produced by electrolytic methods are generally conceded to be of higher purity and more uniform than those produced by other methods.

In the accompanying tables operating data from electrolytic plants in the United States and Canada have been arranged in convenient form. The main points covered are composition of electrolytes, equipment, methods of applying the current and efficiency obtained from the power, raw materials used, and byproducts produced. The tables cover the electrolytic refining of copper and electrolysis of copper-bearing solutions

Energy Consumption

	Kw.-Hr. d.c./Lb.	Lb./Kw. hr. d.c.
Refining:		
Copper, multiple system	0.09–0.16	6.3–11
Copper, series system	0.74	13.5
Lead	0.04–0.05	24.0
Tin	0.085	11.8
Nickel	0.55	1.8
Gold	0.15	6.6
Silver, Moebius	0.31	3.2
Silver, Thum	0.41	2.4
Electrolysis from leach solution:		
Copper	1.0–1.5	0.67–1.0
Zinc	1.4–1.56	0.64–0.7
Cadmium	0.8	1.25

Electrolytic Production of Zinc

	Anaconda Copper, Great Falls, Mont.	Evans-Wallower Zinc, East St. Louis, Ill.	Sullivan Mining Company, Kellogg, Idaho	Consolidated Mining & Smelting, Trail, B. C.
Electrolyte:				
Zinc in feed to cells	110 grams/liter	200 to 220 grams/liter	215 grams/liter	150 grams/liter
H_2SO_4, cell discharge	105 grams/liter	280 grams/liter	280 grams/liter	130 grams/liter
Temperature, deg. C	37-41	35-45	30-45	30-40
Feed to cells	Combination of cascade and individual	Parallel flow (a)	(a)	Combination of cascade and individual
Current:				
Amperes per square foot	30	100	100	30 and 40
Voltage per cell	3.7	3.25 to 3.45		3.7
Current efficiency	94%	87-92%		90-92%
Current kilowatts per generator	9-5,800 kw. (10,000 amp. 580 volts)	1-6,000 kw. (10,000 amp. 600 volts)	2-4,000 kw. (8,000 amp. 500 volts)	(b)
Kilowatt hours d. c. per pound	1.55	1.4		1.56
Anode:				
Composition	Chemical lead	Lead alloy	Lead alloy	Electrolytic lead
Length, width, thickness	45″x24½″x $\frac{3}{16}$″	32″x20″x$\frac{1}{4}$″	32″x21″x$\frac{1}{8}$″	33″x22″x½″
Weight, pounds	110	22		
Mode of suspension	Cast around conductor	Cast around conductor	Cast around conductor	Burned solid connection
Construction	Solid	40% perforated	50% perforated	Solid
Cathode:				
Length, width, thickness	45″x24″x $\frac{1}{16}$″	Immersed 27″x21″	Immersed 27″x21″	36″x24″x$\frac{1}{8}$″
Composition	Aluminum	Aluminum	Aluminum	Aluminum
Mode of suspension	Riveted to copper conductor	Welded to aluminum conductor	Welded to aluminum conductor	Riveted to conductor
Removed	Every 24 hours	Every 12 hours	Every 12 hours	Every 24 hours
Weight of each sheet, pounds	11	22-24	22-23	8-10
Deposition cells:				
Length, width, depth	10′3″x2′10″x4′9″	6′3″x2′6″x3′9″	6′3″x2′6″x3′9″	6′10″x2′3″x3′
Number anodes, cathodes	28, 27	24, 12	20, 10	17, 16
Material of construction	Wood, lead lined	Wood, lead lined	Wood, lead lined	Reinforced concrete, asphalt and sulphur sand lined
Tank mud:	Mn O_2, 40-45% Mn	Mn O_2	Mn O_2	Mn O_2
Amount	1.5-1.75 gram mud per liter feed	4 to 8 grams/liter of feed		
Removed	Every 6 weeks	Every month	Every month	Every 6 to 8 weeks

(a) Entire volume circulated every 1½ hour. (b) 13 motor-generator sets = 26 generators, 4,000 amps. at 125 volts. 10 rotary converters, 4,500 amps. at 550 volts (2 spares). 3 mercury arc rectifiers, 10,000 amps. at 550 volts.

Electrolytic Refining of Nickel and Tin

	Nickel	Tin
Electrolyte:		
Metal content	40 grams per liter	3%
Per cent total acid	20 grams per liter (H_3BO_3)	10.2 (H_2SO_4)
Temperature, deg. C	51 to 57	35
Circulation, gallons per minute per cell	2½	5
Circulation apparatus	Hard rubber pumps	Vertical centrifugal pumps
Current:		
Amperes per square foot cathode	11.5–12	8–10
Voltage per cell	2.4–2.5	0.3–0.35
Capacity of generators	1,100 k.v.a.	4,500 kw.
Current efficiency	93–94%	85%
Kilowatt hours d.c. per pound metal	0.55	0.085
Anodes:		
Composition	Precious metals, ½ oz./ton	Sn 96.0% Bi 1% Sb 0.25% As 0.15% Cu 0.25% Pb 1.0%
Length, width, thickness	36″x27″x2″	33″x36″x1½″
Weight, pounds	425	350
Mode of suspension	Cast lugs	Cast lugs
Life, days	32–33	21
Per cent scrap	36 to 40	25
Cathodes:		
Starting blanks	Aluminum, dipped in sodium sulphide solution	.....
Starting sheets:		
Length, width	36′ x28″	34″x37″
Weight, pounds	11 to 12	8 to 10
Mode of suspension	Nickel loops	Wrapped
Replaced after (?) days	14	7
Weight, pounds	125	100
Deposition cells:		
Length, width, depth	16′ 9½″x2′10½″ x5′ 2″	12′ 11″ x 3′5″ x 3′6″
Number of anodes, cathodes	29, 30	26, 27
Electric connection	.....	Walker
Cell material	Concrete, mastic and gilsonite lined	Wood, lead lined
Anode mud:		
Per cent of anode	.....	5
Composition:	.....	Pb 20, Cu 5, As 3, Sb 5, Sn 30, Bi 20%
From primary anodes	Precious metals, 12 oz./ton, Ni 30–40%	.....
From secondary anodes	Precious metals, 500 oz./ton	.....

obtained by leaching processes, production of zinc, cadmium, lead, nickel, tin, silver, and gold.

Comparison of the power requirements for the different metals is of great interest. This has been covered in a separate table giving pounds of the various metals per kilowatt-hour and the kilowatt-hour consumption per pound of metal produced. On the basis of these

Copper from Electrolysis of Leach Solutions

	Chile Copper		Inspiration Copper
	Starting sheets cells	Insoluble-anode cells	Insoluble-anode cells
Electrolyte:			
Specific gravity			1.169
Grams per liter copper	35—40	36.2	23.3
Grams per liter H_2SO_4	100	46.09	30.6
Grams per liter chlorine	0.035	0.13	
Grams per liter total iron		4.62	19.0
Grams per liter ferric iron		0.01	5.3
Temperature, deg. C	40—45	30—40	33.6
Spent electrolyte:			
Grams per liter copper		14.44	18.2
Grams per liter H_2SO_4		78.54	45
Grams per liter chlorine		0.21	
Grams per liter total iron		4.60	19.0
Grams per liter ferric iron		1.13	9.2
Temperature, deg. C			42.5
Current:			
Total	19,600		
Current density, amperes per square foot	17.8	10—12	11.4—11.8
Current efficiency, per cent		88.4	64.6
Voltage per cell		2.24—2.4	2.37
Kilowatt-hours per pound copper		0.98—1.04	1.54
Pounds copper per kilowatt-day		23—24.5	15.6
Anodes:			
Material	Copper, soluble	Chilex, insoluble, grid shape	8% antimonial lead
Length, width, thickness			38″x40″x½″
Mode of suspension	Cast lugs	From bar	From bar
Per cent scrap	25		
Spacing	5″	4 or 4.5″	4.5″
Cathodes:			
Material	Copper or lead blanks	Copper	Copper
Length, width, thickness	37½″x59″x½″	37″x50″	44″x42″
Weight, pounds		153	90—100
Mode of suspension	Riveted copper bar	2 small side loops	2 side loops
Replaced after (?) days	1		5
Weight starting sheet, pounds	13		11
Deposition cells:			
Length, width, depth	18′ 8″x3′ 5″x5′ 10″	18′ 8″x3′ 5″x5′ 10″	33′x4′x4′ 3″
Number of anodes, cathodes	43, 43	50, 49 or 56, 55	85, 84
Electric connection	Walker	Walker	
Material of construction	Reinforced concrete, mastic lined	Reinforced concrete, mastic lined	Lead lined
Leaching			
Leaching vats:			
Material of construction	Reinforced concrete, mastic lined		Concrete, lead lined
Length, width, depth	150′x110′x17′ 5″ or 150′x110′x19′ 6″		175′x67′ 6″x18′
Average charge per tank	10,170 metric tons		9,000 short tons (capacity dry ore)
Ore:			
Per cent copper	1.62		1.16
Per cent copper, insoluble in acid	0.053		
Per cent oxide copper			0.68
Per cent sulphide copper			0.48
Tailing:			
Total per cent copper	0.167		0.133
Per cent water-soluble copper	0.022		0.002
Per cent oxide copper acid soluble			0.025
Per cent sulphide copper			0.106
Extraction:			
Per cent total copper	90.24		88.55
Per cent oxide copper			96.02
Per cent sulphide copper			78.05

Electrolytic Refining of Silver

	Raritan Copper Works Perth Amboy, N. J.		U. S. S. Lead Refinery East Chicago, Ind.
	Thum Cell	Moebius Cell	Thum Cell
Electrolyte:			
Grams silver per liter	60	60	50—55
Grams copper per liter	40	40	60—65
Nitric acid	None	None	Trace
Circulation	Gravity	Mechanical scraper	Gravity
Current:			
Amperes per square foot. anode	50	50	40
Voltage per cell	3.5	2.7	3
Current per cell	150 amp.	450 amp.	160 amp.
Current efficiency	93—95%	98%	
Anodes:			
Composition	Ag 98.5%, Au 1%, Cu and precious metals, trace	Ag 98.5%, Au 1%, Cu and precious metals, trace	Ag 95—98%, Au 1—5%, Pb, Te, Se. Bi
Life	36 hours	36 hours	96 hrs. (5 anodes per charge)
Per cent scrap	None	15—20%	Very low
Anode basket, length, width	24"x21"		32"x19.5"
Cathode material	Carbon and graphite	Stainless steel	Graphite
Cells:			
Length, width, depth	48"x23"x7"	29"x25"x22"	54"x24"x9"
Material of construction	Mastic lined concrete	Mastic lined concrete	Acid-proof stoneware
Cell arrangement	Series	Series	Series
Anode slime	1—2%	1—2%	2—5%

figures curves have been plotted showing the cost in cents per pound of metal at varying power costs, given in cents per kilowatt-hour.

The high power cost of processes using insoluble anodes is clearly seen from these tables. In the production of nickel the high power cost results from the use of diaphragm in the cell, which causes an increase in the cell voltage.

■ ■ ■

Vanadium Recovery at Rhodesian Broken Hill

RHODESIAN BROKEN HILL, in addition to the difficulties normally attending electrolytic zinc production, faced the problem of treating an ore containing vanadium. The successful solution of this problem reflects creditably upon Mr. R. H. Stevens and his staff of metallurgists, who have developed a process that provides for complete removal of vanadium from the electrolyte and also permits the recovery of this valuable metal. Production of vanadic oxide was started in January, 1930, and a minimum monthly output of 30 tons was reached in March; the plant is equipped for an annual production of 600 tons, with facilities for future expansion.

The ores, containing vanadium in the form of descloizite and vanadinite, occur in a dolomitic formation and have originated by replacement of susceptible beds in the dolomite by crosscutting mineralizing fissures. The mode of occurrence of the oxidized and primary ores is characteristic; the more important orebodies always consist of two parts—a central portion of massive sulphides, zinc blende and galena, surrounded by oxidized ore, locally designated as zinc silicate, but in reality a mixture of quartz, iron oxides, and zinc silicate, with smaller amounts of lead and zinc carbonates and vanadium minerals. This oxidized ore is high grade, containing 30 to 55 per cent zinc plus lead. The rich vanadium ores have a well-defined marginal relation to the oxidized ores, being developed on their border and mainly in the broken ground between the massive oxidized ores and the dolomite, as well as in open fissures and cavities. A small percentage of vanadium is also found throughout the entire body of oxidized ore.

Vanadium dissolves during the process of extracting zinc from the ore and must be removed, because a pure solution is essential for successful electrolysis. Its high value also makes the recovery of great economic importance. The method used is precipitation as zinc or iron vanadate, or a mixture of the two. The precipitate is filtered in a filter press, washed to remove soluble zinc, and discharged to a storage bin. Filtrate and wash water are returned to the zinc circuit. The precipitate is converted into a slurry in a grinding mill and, pumped to storage tanks, where it is agitated. The pulp is then withdrawn as needed in the first step of the process of recovery, in which vanadium is dissolved in a solution of caustic soda, containing at least 75 grams NaOH per liter, and prepared by treating sodium carbonate with burnt lime.

Definite proportions of slurry and caustic solution are agitated from one to two hours at about 100 deg.C. in a steam-heated iron vat. Vanadium dissolves as sodium vanadate, iron and the main part of the zinc remaining insoluble. The pulp is filtered in a press, washed, broken up in a pug mill, and discharged to an agitator, where the solids are suspended in zinc solution and pumped back to the zinc circuit.

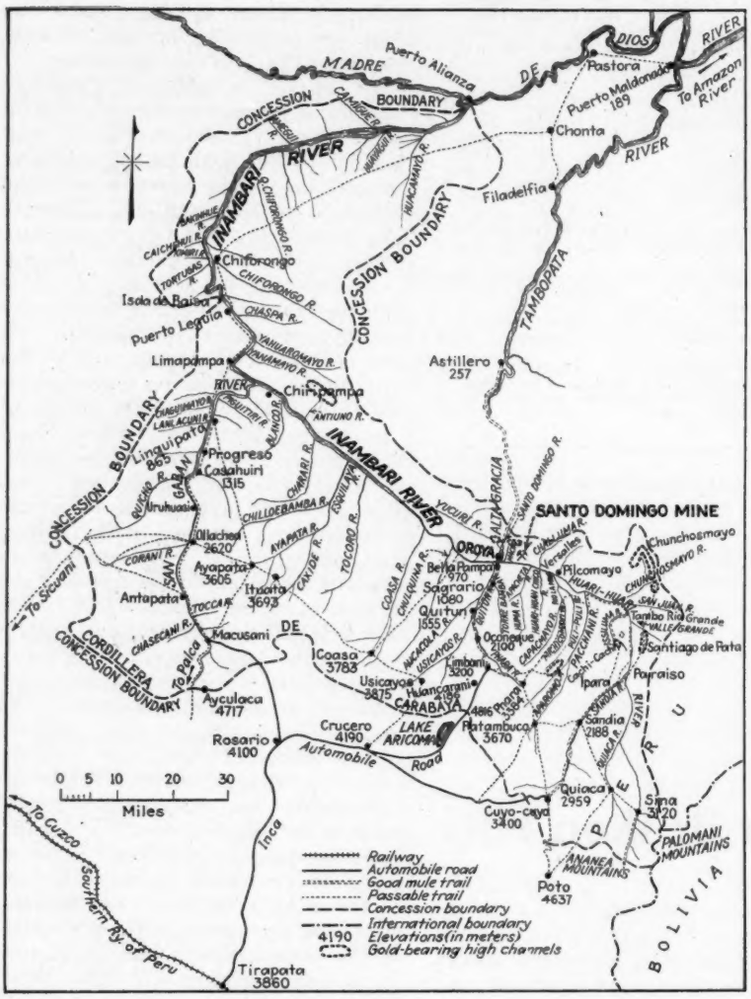
The filtrate, a solution of sodium vanadate, is pumped to the precipitation tanks, where vanadic hydrate is precipitated by the addition of sulphuric acid until the solution contains an excess of 5 grams per liter free acid. Steam is then turned on, and the temperature allowed to rise to a maximum of 95 deg. C. If preferred, the acid may be added while the solution is heating, or after the desired temperature is reached. All three methods work equally well. Acid must also be added during the precipitation, to maintain a minimum acidity of 5 grams per liter. An excess of 25 grams per liter has, however, no harmful effect. As the temperature rises, vanadic hydrate precipitates. Maximum precipitation is obtained at the boiling point, and the final temperature is an economic consideration, depending on the cost of steam. Excess acid lowers the precipitation efficiency, but gives a purer product; addition of acid is therefore regulated to give maximum precipitation at the desired purity. The residual impurities in the solution remain dissolved and the vanadic hydrate is of high purity. When the precipitation has reached the desired standard, the pulp is treated in a wooden-plate filter press. The filtrate is run to waste, or re-treated, if the vanadium content is high, by returning the solution to the zinc circuit, or by precipitating the vanadium with lime if the content of soluble salts is too high. When the lime is later used for causticizing, the precipitated vanadium is again recovered.

The vanadic hydrate in the press is treated by counter-current washing, the strongest wash water being returned to the precipitation circuit. After a thorough wash the cake is fed to a gas-fired furnace, where free and combined moisture is eliminated, and the dehydrated oxide fused. The fused oxide is crushed and bagged. It contains a minimum of 90 per cent V_2O_5 and may run 95 per cent or better, and is almost free from phosphorus and sulphur, the impurities consisting of alkalies, with small amounts of silica and iron.

Placer Gold in Peru

H. D. Keiser

Assistant Editor



Placer-mining concession granted to Clarence Woods by the Peruvian government

ONE of the oldest mining areas in the world is the Inambari gold district, in southern Peru, which stretches across the provinces of Carabaya and Sandia from the Bolivian border to the Madre de Dios River. The Spaniards, on their arrival in the region in 1533, found the Incas using gold profusely, particularly in the ornamentation of their temples. Tombs of the rulers of a people antedating the Incas also revealed various implements and ornaments made of the metal. Mining, therefore, must have existed in the region many years prior to the earliest dates that appear in historical records.

The gold occurs in quartz veins penetrating a slate formation that covers the region and forms the bed of the Inambari River from its source in the south at an elevation of 20,000 ft. to its confluence in the north with the Madre de Dios at an elevation of 1,350 ft. Owing to heavy rainfall and the relative softness of the slate, erosion in the region has been severe, gold from original vein sources occurring as alluvial gold throughout most of the Inambari watershed. Moreover, deposits in old stream channels have been redeposited in stream beds at lower elevations.

Although these deposits, both vein and alluvial, have been mined for years, operations within the area are confined to those at the Santo Domingo mine and the small placer operations or "gold farms" of Indians, both of which have been described in recent issues of this publication.[1] Exploitation of the deposits by modern methods has been delayed principally by the inaccessibility of the region. Discovery of the Santo Domingo mine and the subsequent construction of a road from Tirapata, however, have been instrumental in drawing attention to the Carabaya or southern part of the district.

Following his acquisition of the Santo Domingo mine in 1928, Clarence Woods visited some of the near-by "gold farms" along the Inambari, where the Indians recover $1 to $2.50 per day in gold. He was impressed by the apparent values in the alluvials and decided to investigate the placer-mining possibilities of the district. In this endeavor he became associated with William C. Gates, an American prospector who went to Peru twenty years ago and has been prospecting the Inambari watershed almost continuously ever since. Gates found both the upper and lower Inambari gold-bearing, and to him belongs the credit for revealing the potential wealth of the district.

Exploration trips made by Woods with Gates along various branches and tributaries of the Inambari led Woods to apply to the Peruvian government for a placer-mining concession for the exploration and exploitation of the allu-

Dredging ground at the confluence of the Pacchani River with the Inambari

This article is based on an interview with Mr. Clarence Woods that took place several weeks ago in New York during a short visit he made to that city.

[1] "Resuscitating a Gold Mine in the Peruvian Andes," by H. D. Keiser; *Engineering and Mining Journal*, Sept. 25, 1930; Vol. 130, No. 6, pp. 283-4. "'Gold Farms' of the Inambari:" *Engineering and Mining Journal*, Feb. 23, 1931; Vol. 131, No. 4, pp. 172.

Clarence Woods, right, and William C. (Swift Water Bill) Gates, pioneer American prospector to enter the Inambari district

This photograph was taken on the summit between the Capacmayo and Michicomani rivers. The old Inca trails in the district are along the mountain ridges, and in places, where they were too steep for mules, the Spaniards, who mined in the region from 1538 to 1775, constructed flights of steps, as shown here.

vial deposits in the watershed of the Inambari. Such a concession, covering more than 5,000 square miles, as shown in the accompanying sketch map, was granted him in November, 1930. Referring to the possibilities of the district, Mr. Woods said:

"Shortly after the concession was granted I made an eighteen-day trip through the upper Inambari section, examining the Puli-Puli, Pacchani, Pilcomayo, Chunchosmayo, Valle Grande, Cachi-Cachi, and Santiago de Pata deposits. I panned in many places; talked with many Indians; and purchased 13 oz. of gold. I met only one miner who could speak Spanish, and there were about 250 Indians mining in the section investigated. During the last 155 years these people have made no advancement whatsoever, and, undoubtedly, many mines that were worked prior to the expulsion of the Jesuits in 1775 are idle today. The area affords a remarkable opportunity for the application of modern mining methods.

"About seven square miles of probable dredging ground exists in the deltas of the streams flowing into the upper Inambari and three square miles in that part of the main river. This gravel is about 30 ft. deep and contains values that are estimated to average more than $1 per cubic yard. According to estimates, these deposits would provide dredging ground for the operation of 34 dredges handling 2,500 cu.yd. per day for a period of ten years, and, at a dredging cost that would not exceed 50c. per cubic yard, the annual profit per dredge would be about $450,000. Additional deposits include those in: (1) hundreds of box canyons of the tributaries flowing into the Inambari; (2) numerous ancient river channels and high banks; (3) the lower Inambari, which section comprises 75 per cent of the total area of the concession and probably contains even more important dredging possibilities than the upper Inambari."

One of the provisions of the decree granting the concession specifies that a map shall be prepared of the region showing the location of the areas in which operations are proposed. Arrangements for the preparation of an aërial photographic map of the concession to be used for such purposes, among others, have been made with the Shippee-Johnson expedition, which is in Peru photographing Inca ruins. Two Bellanca "Pacemaker" planes, with 300-hp. Wright "Whirlwind" engines, will be employed in the work. One of the planes was especially built for mapping purposes, being equipped with aërial photographic apparatus of the latest design, as well as superchargers for high-altitude flying.

In addition to the landing field at Tirapata, along the Railroad of Southern Peru, another will be constructed at Oroya, on the Inambari. This field will serve as the headquarters for initial aërial operations within the concession. Subsequently, other landing fields will be established as they are required. The aërial map, as soon as it is completed, will be employed in the exploration of the concession, inasmuch as it is expected to reveal numerous hitherto unknown ancient river channels and river bars, particularly bars in box canyons that have been considered inaccessible. Interpretation of the map and supervision of exploration will be in charge of the geologist on the staff of the company that is being formed to operate the concession.

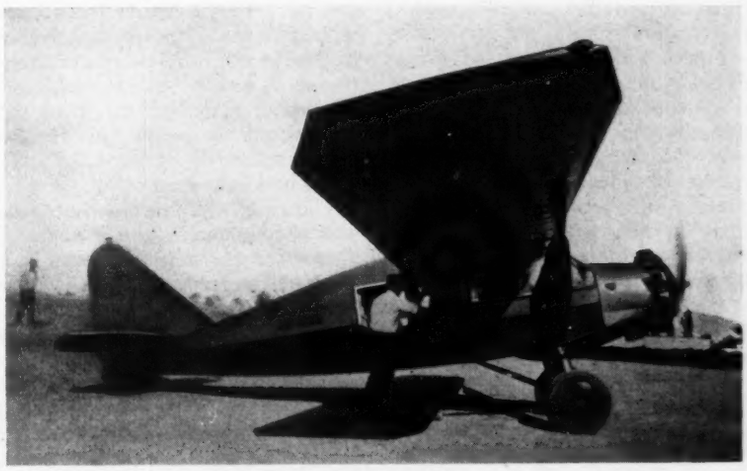
Plans for the exploitation of the concession, as announced by Mr. Woods, are as follows:

1. Prospecting parties, equipped with drills, are to be placed in the field immediately to prospect the most promising dredging sites in the upper Inambari. When sufficient ground has been proved to justify the installation of dredges, the road from Tirapata to Huancarani will be extended to Oroya and for a distance of 25 miles both up and down the Inambari from Oroya. Prospecting will require several months and road building about a year.

2. Capacity of the power plant at Bella Pampa, where $200,000 has already been spent in hydro-electric development, will be increased from 500 to 1,000 hp. and a transmission line erected along the Inambari. Adequate power will then be available for the operation of dredges, as well as drag-line scrapers, clamshell-bucket cranes, and electric shovels that will be employed in handling the gravel in river bars.

3. As soon as prospecting is completed, mining by sluice boxes or hydraulic lifts will be applied to many of the torrential streams, in which the concession abounds. The large streams will be worked by the company; leases on the deposits in the smaller streams will be granted responsible individuals. High gravel banks that occur in the upper Inambari will be mined by hydraulic giants, supplanting ground-sluicing methods employed by the Spaniards in treating such deposits from 1738 to 1775.

4. Sites along the Inambari suitable for the operation of drag-line scrapers will also be leased to responsible individuals.



One of the Bellanca planes used in the aërial mapping of the concession

The Witwatersrand

Experiences and Reflections of a Junior Engineer

Bernard Beringer

Morococha, Peru

I HAD the good fortune to spend four and a half years in that great mining field, the Witwatersrand, during the post-War period when the issue at stake was successful industrial enterprise or failure. The mine at which I worked and played, about three miles east of Johannesburg, was reached by train or street car. A description of it, and the life lived there, may serve as typical for the Rand. Picture an area of about two miles square, on which are scattered the workshops, headframes, change houses, mill and cyanide works, rows of dwelling houses with small gardens, and a recreation hall, football grounds, golf links, tennis courts, bowling green, and so on. During the day can be heard a general conglomeration of noises, with the steam hammers and drill sharpeners in the smiths' shops predominating, and perhaps a recurring motif as the skips of a near-by shaft tip their content into the bins. Also, of course, can be heard the muffled murmur of a hundred stamps, that continues day and night, but to which one becomes accustomed. In fact, only when the mill stops, as it does on rare occasions, does one realize how much the sound is part and parcel of the mine atmosphere.

The Start—as Assistant Sampler

My first job was that of assistant sampler, preceded by a few weeks as sampler learner, with a nominal wage that just covered the cost of existence —rather an invidious début for a mining engineer. Being possessed of the conceit of youth, I thought so; also, disillusionment is bound to be felt by a graduate in a profession in which leadership of men, and the application in practice of scientific principles, are paramount, and technical training is relegated to the position only of a stepping-off stone—eminently essential, but, by the nature of things, incomplete in itself.

Sampling is undoubtedly the best introduction to the practice of mining. The work has to be methodical, and meticulous care is practiced in computing the values of the orebodies—which impresses on the new engineer the fact that mining is a highly developed science in which irresponsibility of any sort is manifestly out of place.

Having passed through the stage of sampler learner I became a complete sampler. For several weeks I was given those stopes to sample that lent least scope for erroneous conclusions the result of inexperience. Then came the time when a definite section of the mine was handed over to me for stope sampling, and the correlated results were filed as representing finished conclusions.

The work of sampling is interesting. We went underground at 8 o'clock in the morning and returned to surface about 2 in the afternoon. From 3 to 4:30 was spent in the samplers' office, where the work was mainly clerical. Below ground the work is strenuous. All chiseling of the samples has to be done by the white man, and the rock is hard in most places. His two native assistants carry the samples, which vary in number from 20 to 40 according to the width of the ore in the stope, and help generally.

The orebody consists of bands of quartz conglomerate in a country rock of quartzite. In it the bands converge and diverge in a manner that forces the sampler to wash the stope face thoroughly, so that he may be certain that the miners leave no gold-bearing band of reef in the footwall, hanging wall, or mine what may be unpayable. The sampler makes sketch sections of the orebody, so that the mine officials, on perusing the sample sheets, may be warned of irregularity.

Sampling on the Witwatersrand has to be executed with greater precision than in many other fields. The ore is low grade, and an error in sampling of half a pennyweight in the estimated value per ton might turn a profit into a loss. Also by, say, reducing the stoping width so as to leave out an unpayable band of reef, a loss might be turned into a profit.

Eight of us were doing this sort of work. One, the chief sampler, with the senior assistant, was responsible for the sampling of all development—that is, shafts on reef, drifts, winzes, and raises. Such work was the task of the two experienced men. The chief sampler was a Dutchman, the South African designation for the descendants of the first Teutonic invaders of what is now known as the Union of South Africa. Some Dutchmen have French names, which they inherit from the Huguenots who came to the Cape in the early days and found the Protestant atmosphere more to their liking than the religious intoleration in that part of Europe whence they came.

Boer War Still Rankles

The chief sampler was an educated man, but of a generation inclined to retain an inherent dislike of the British in general. This is understandable when one realizes that less than twenty years before the period of which I write he had for three years been chased about the country he considered his own by those harbingers of industrial civilization, the British. In regard to the Boer War, in which the real inhabitants of the country, the natives, were not considered at all, the fact must be emphasized that the Dutch were then inclined to be insular and non-progressive. They occupied a large new country rich in mineral and other natural resources. Civilization demands that full use be made of Nature's gifts. At that time, the British found themselves the carriers of industrial progress throughout the length and much of the breadth of the African continent. The Boer War was not a mere national conflict.

I found, then, that the chief sampler was slightly averse to my type, although he did nothing underhand to lessen the

efficiency of my work. It was disturbing, however, to feel that I was not really welcome. Of the other members of the sampling staff, one was a first-class example of the English South African, possessing most of those qualities of manhood to which the majority aspire. Two years as a private soldier in France, culminated by shell-shock, had not tended to alter him. It was annoying to notice that he was the butt in the sample office of humorous remarks from two younger countrymen of his, and of a Johannesburger whose sense of humor was a little too strong. I was pleased that my arrival helped to transfer some of the jokes to myself, as I was not deaf from shell-shock and thus was more able to parry the wit.

Promotion Slow; Wages Low

The development sampler was an Englishman, who, with a young Dutchman, completed the staff of samplers. All these, during the strike and Red revolt about two years later, proved themselves to possess sterling qualities — men whose friendship was worth having.

The sampling department on a Rand mine usually comes under the jurisdiction of the chief surveyor. For about five days in the month the samplers assist the surveyors at stope measuring. In this manner the way is paved for the samplers to be promoted to surveying as vacancies occur in that department. Many technically trained men do one year or so at surveying, after having completed perhaps a year's sampling. Others, like myself, turn to general mining. In my case, thanks to an international misunderstanding which resulted in my generation "forming fours," I could not spare the time.

As regards salary: An assistant sampler or surveyor receives an increase in pay every three months, amounting to £2 10s. per month. This continues for so long as his work is satisfactory and until a certain maximum is reached, which is about £35 per month. The chief surveyor and the chief sampler, of course, receive considerably more than this.

After a year's sampling I was given research work to do, in connection with the wear and tear on drill steel, which incidentally qualified me to sit for examination for a blasting certificate. After a few months of research work I was transferred from the list of underground officials and became a miner and member of the Mine Workers' Union, which I had to join.

As regards the social side of life during all this time: The New World practice of hard work and hard play goes a long way toward making the Rand one of the most go-ahead mining fields in the world. Most officials, and many others, lived on the mine itself, the bachelors' quarters being a short distance from the married men's bungalows. Excellent food was provided at the mine boarding house, at a cost of £6 10s. per month, which was exceptionally cheap considering the service provided and the fact that South Africa is an expensive country. A Cornish miner in describing the food said that every day is like Sunday, and Sundays are like Xmas Day!

Each of us lived in a combination bed room and sitting room. Some of the senior officials had two rooms. We were charged 10s. per month rent and 3s. for electric lighting. Furniture we had to provide, and this item was heavy. My room was not luxurious, yet the furniture cost over £40. Three others and myself shared the services of a Kafir boy, who made the beds, scrubbed the floors, and generally kept things in good condition. He cost us £1 per month each.

Ample sport was to be had, and of a fairly high order. Most evenings could be passed by arranging a foursome or singles at tennis. After the evening meal one could spend a few pleasant hours in the recreation hall, with its well-stocked library, reading room, and billiard hall. Saturday afternoons could be occupied by tennis or golf or bowls; and, in the winter, by Rugby football. On Sundays, more Rugby and tennis were rendered possible by freedom from religious prejudices. Thus full advantage was taken of the open air on the Sabbath for exercising the body and lungs. Among other forms of amusement provided at the mine was a monthly dance and an occasional smoking concert. Saturday evenings were usually spent in Johannesburg, where one went with a small party of three or four, the better to taste the fruits of relaxation. Although the work is hard, the opportunity for recreation of both the mind and the body is perhaps as great as anywhere, in distinct contrast to many mining fields where the work is less arduous but where it is possible to be cursed with loneliness, or ill health, or both.

Heading for Mine Captain's Job

My first eighteen months on the Witwatersrand were spent fairly pleasantly. The life was congenial, and I built up a wide circle of friends. From then onward, having become a miner, and also having started to study for the mine captains' certificate, life was harder. Every Thursday evening and Sunday morning I went to Johannesburg to attend classes in the theory and application of underground work—all this in addition to learning to hold down work that was entirely new to me. The work of ganger is hard and responsible. An error in judgment may result in a blasting accident or fall of ground, both attended by loss of life. Also, the efficiency of the work is booked and tabulated month by month, and little sympathy is shown to the man who exhibits no improvement after the poor results of the first few weeks, which are passed without comment.

My first work as ganger was sinking winzes. I had charge of three, all of which were over 200 ft. deep, dipping at 35 deg. The physical effort of merely descending and ascending these, let alone charging the holes with explosives and repairing the machines and cutting and capping the fuses, was in itself a day's work. As a white man I was responsible for the positioning and pointing of all the holes and seeing that the regulations regarding safety and health were carried out.

Four jackhammers were operated, and the number of natives was eight, which included the winch boy and boss boy. When I took over this work the machine boys were untrained and the boss boy was totally unsuited, which was an unfair handicap for a new miner like myself. This would have been avoided if the shift boss had been a little more competent in organizing his personnel. But he was efficient in other respects. The work of training both myself and my gang was hard; the training of a gang complete is rarely required, even of an experienced miner in a well-run section.

The Strike of 1922

A poor beginning often eventuates in a successful conclusion. After the unfortunate start, when at times I could not learn from my own mistakes because they were so many, gradually —very gradually — things improved, until at the end of a year I found myself high up on the mine efficiency list, was complimented on my development achievements—then raising with telescopic drills — and received in pay over £70 in one month, on the contract system. But those initial days will always be a nightmare. Mining is too hazardous to be learnt by individual experience, and I had missed those months usually served as a learner. When the great strike broke out in 1922 I was still a ganger on development work—but more about this later.

Six other ex-officials were working as miners, including two friends of mine from the sampling office, one of whom was the shell-shock man previously mentioned. So I was not alone in a position of which one became impatient as month after month went by with no apparent chances of promotion to the rank of shift boss.

About the miners: Prior to the War the greater proportion were Englishmen from Cornwall and the North, with a large sprinkling of English South Africans, and a few Dutchmen. During the War many of the best joined the army, and some of the older ones who stayed behind died of phthisis. Neither type were replaced by new arrivals from England, but by back-veldt Dutchmen, so that when I was out there as a miner my fellow workers consisted mainly of Dutchmen, with a sprinkling

of returned soldiers, many of whom were English and Dutch South Africans and some Australians, including a small minority of the more unpleasant type of English and Australian trade unionist. In contrast to this the mechanical engineering department contained many Scotsmen and Englishmen, all strong trade unionists but of the desirable type.

My South African experience confirmed a belief that trade disputes are not merely questions of wages and hours, but are mainly psychological. Jack tries to be as good as his master, although the reasonable trade unionist considers that he is only trying to obtain a fairer distribution of the fruits of industry, so that his home comforts may be compatible to the state of civilization to which he has attained. On the Rand, few white employees received less than £30 per month when I was there, and many miners obtained monthly checks amounting to as much as £80, and even £100. Actual manual labor was done by the Kafirs, whose remuneration was from £3 to £7 per month, so that most white men were really supervisors, although skilled artisans, and had the same sort of work to do that they would have had in the Americas or in England.

Effects of the "Color Bar"

In spite of the fact that wages were high and positions satisfactory, dissatisfaction was rife. Trade unionism carried to its logical conclusion would have concentrated on improving the lot of the Kafir. But, no. The insidious rumbling of discontent emanated from the lower grades of the white supervisors, who were already exploiting a lower order of men and reaping more than their share of the fruits. The move was suggestive of Bolshevism — a noisy minority impatient under discipline and led by opportunists who wished to take the reins of control into their own hands. They were encouraged by the type of person who hoped to catch fish in such troubled waters as would eventuate from a successful revolt.

The crude and excitable back-veldt Dutchmen formed suitable soil for the sowing of discontent; and, to the onlooker, their racial antipathy for the British seemed to be converted to a restlessness against law and order. Usually the leaders who encouraged such a diversion of sentiment were English socialists, who played cleverly on the inferiority complex of these crude men, until, in 1922, "The balloon was ready to go up."

To emphasize further that racial antipathy played no direct part in the events that I shall describe: Those who finally established law and order, and made the mine manager master in his own house, were the thoughtful and sportsmanlike men of both races. Incidentally, the Dutch casuality list on the law-and-order side was a depressing sight, but a great and able demonstration of their fitness to rank as a civilized people, and admirable partners for the British to have in building up a United South Africa.

The unfortunate form of trade unionism that obtained had such a grip on Rand industrialism that efficiency was becoming a dead letter, and the Chamber of Mines found itself obliged to continue with a policy of *laissez faire,* resulting in more than half the mines closing down; or to face facts and re-establish managerial control and efficiency. Fortunately for South Africa, it chose the alternative; and, at risk of life and property, delivered a so-called ultimatum to the unions, embodying reorganization of labor, the reduction of the absurdly high contract rates of the miners, and the dismissal of about 2,000 redundant white men (junior supervisors); in other words, generally to establish conditions whereby the efficient worker would receive good though not exorbitant pay, and the indifferent or lazy man would be paid accordingly.

Negotiations between employers and men had been progressing for many months. The object of the employers was to increase efficiency and at the same time to reduce wages, that had been inflated during the War, to a reasonable limit. The object of the men, apparently, was to retain what they had, and, if anything, to wrest yet more from industry. Any talk of efficiency, especially on the subject of the ratio of white to black employees, was met by the cry that the color bar was being swept away. From this evolved the battle cry of the strike—"A White South Africa." Attempt to give the men more responsibility, by making them supervise more natives, was believed by many trade unionists to be merely the thin edge of the wedge that would remove the color bar and thus force the white man to compete on equal terms with men of a lower social order and standard of living.

After several months of unsuccessful negotiation, the Rand found itself the center of a large strike, which embraced the coal miners, who left work on Jan. 1, and the gold miners and power-plant employees, who quit on Jan. 9, 1922.

To go into details of the strike and its gradual evolution into a Red revolt would make interesting reading, but sufficient parallels are to be found in similar experiences of many mining men to justify dismissal of a distressing subject. Suffice to say that the first month of the strike disclosed nothing worse than the maltreatment of strike breakers and their families—the men who considered, most of them, that loyalty to employers counts, and that in a free country the individual has a right to decide when he will work and when not.

As the weeks passed the extreme element among the strikers resorted to isolated murders of mine officials and others returning to their homes from the work of keeping the mines unwatered. Hence, gradually, public opinion turned; and when, early in March, the strike turned into an armed Red revolt, the bulk of the public was willing to be mobilized on the side of law and order. Nevertheless, for nearly a week the fate of the Rand was in the balance. On the mine I was assisting in defending, we were cut off from the outside world for five days. We missed being attacked solely because the liaison arrangements between two rebel commandos was faulty. The revolt itself was serious. Innocent natives in their compounds were fired upon. Officials and special police were murdered after surrendering at the Brackpan mine. But enough! Order was eventually established at the cost of over 300 lives.

Making the Grade Is Hard

Shortly after the strike I finished with development and became a ganger in charge of a stope. I had my same Kafir boys with me, and we all had to learn to use machines without bar-and-arm support as with development, and to drill holes in an entirely different manner. As before, the results from the first month were bad; the next, better; and then I began to vie with my shell-shocked friend in making our efficiency figures comparable to those of the most experienced miners.

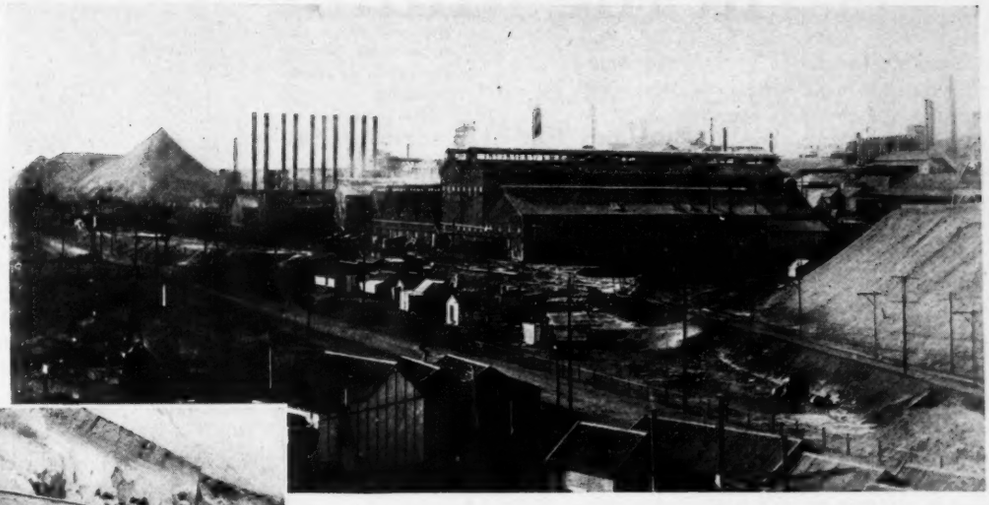
Discipline, as the Rand had never known it before, having been established, we gang leaders had to work hard. At this time also I started to study and attend lectures in preparation for the mine managers' examination. In other words, followed the hardest months of my life. The mine managers' examination consists of five subjects: (1) general mining; (2) mining law; (3) mechanical engineering and electrotechnics; (4) surveying; (5) geology. the actual examination covering three days. Many applicants fail in their first attempt. I am reminded of one day a few years ago when I walked up the Champs Elysées, in Paris, on a hot summer day and eventually reached the Arc de Triomphe, to see registered on it only the battles that had resulted in victory. So I will say that I was successful in the examination, without stating whether or not I had to make one attempt or more to accomplish it.

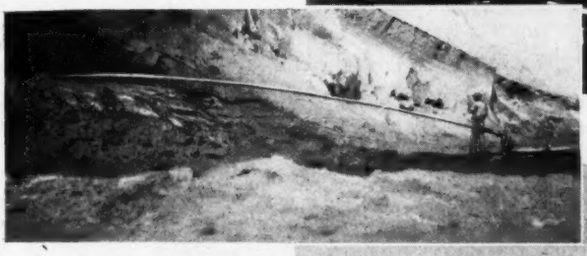
Some six months after the strike I was made a shift boss, and in that capacity continued until I left the Rand. The mine manager on saying farewell wished me luck in a wider field, but gave a warning which I afterward appreciated only too well! "You are leaving large-scale mining, and you may wish one day that you had not, when that pump delivers just one gallon per hour too little"—a homily on an engineer's worries when working for a company with small capital.

(To be concluded)

Along the Golden Mile

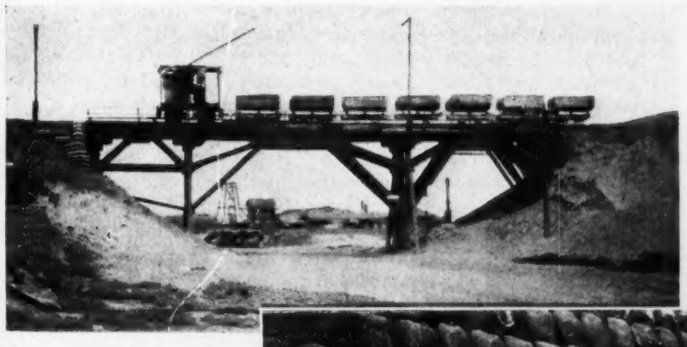
Although its output has declined, Kalgoorlie, in Western Australia, is still an important gold camp. At the right are shown some of the mines, mills, and tailing dumps.

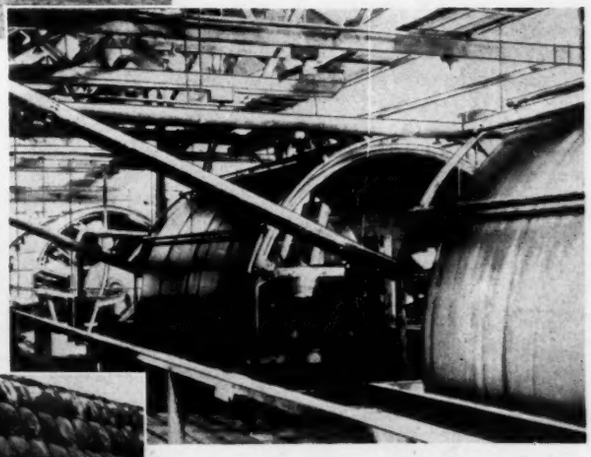




Above, sluicing the Golden Horseshoe tailing, and, at the left, the cyanide vats in the re-treatment plant

Re-treatment of the immense Golden Horseshoe tailing dump at Kalgoorlie is a sign of metallurgical alertness and engineering initiative. Two million tons of tailing, containing about £700,000 in gold, will be retreated in a plant that started operations in February.





Electric haulage is used in carrying material to the Great Boulder dump, a mile from the mine. At the right is shown the manner of retaining the tailing on the dump.

Above are shown the Oliver vacuum filters in the re-treatment plant. There are four of these, each capable of handling 10,000 tons of tailing monthly.

Internal-Combustion Engines in the Mining Industry

This article, the second and last of a series, discusses the comparative advantages of the Diesel and the steam engine, respectively; why internal-combustion engines are used. Costs for fuel are given, and other supplementary data.

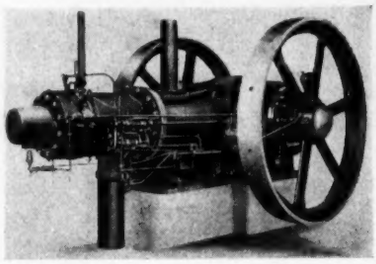
A. H. Hubbell
Associate Editor

THOSE answering the questionnaire referred to in the previous article gave various reasons for using Diesel, or semi-Diesel engines, as the case happened to be. Condensed and summarized they would read: Lack or insufficiency of other power; high cost of purchased power to small consumers; low first cost of plant compared with equivalent power plants of other types, especially in districts where long, expensive freight hauls were necessary; portability, insuring to some extent an engine's resale value; economy of operation, irrespective of size of plant, largely because of the Diesel's ability to burn cheap fuel oil efficiently; ease in starting, simplicity in operation, and reliability. In a few exceptional cases reported, the installation was standing idle after serving the purpose for which it was installed—namely, to bring the enterprise through the early stages of development or until an ample supply of cheap electric power became available.

Fuel Costs—An explanation of the popularity of the internal-combustion engine in the mining industry in Nevada, as evidenced in Table II, may possibly be found in part in the cost of coal in the various camps considered. At the time of compilation, this is $9.50 per ton at Battle Mountain, $12.50 at Beowawe, $12.65 at Betty O'Neal, $18.75 at Cortez, $14 at Eureka, $5 to $8 at Kimberley, $20 at Lovelock, $21 at Midas, $16 at Tonopah, and $28.50 at Winnemucca. At the same time it must be borne in mind that fuel oil is naturally higher, also, where a long haul is required. Oil of 27-plus gravity that brings 4.3c. per gallon at Goodsprings costs 13c. at Winnemucca, so the favor enjoyed by the type of engine considered is not entirely explainable by comparative costs of fuel. Rather, it is probably to be attributed to a general application of the various features cited in the foregoing paragraph.

In Arizona, California fuel oil costs $1.47 to $1.87 a barrel at Douglas, and $1.84 per barrel or 4.7c. per gallon at Globe. Some miles out of Globe, one company is using fuel oil which costs it 4.2c. per gallon at Globe and 7.38c. at the mine after paying cartage. Similarly, at Patagonia, the price is 7.5c. per gallon f.o.b. mine. In contrast, where a company is situated close to oil fields, its fuel oil may cost it considerably less than any of the prices quoted. In Table III is given the cost of fuel oil, or its equivalent, and coal in various mining districts throughout the country where Diesel or semi-Diesel engines are being used.

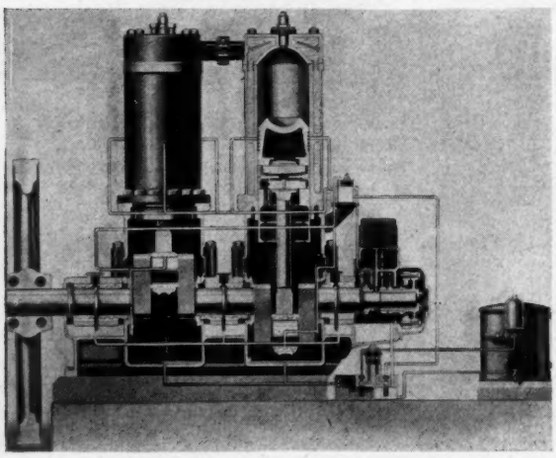
Diesel vs. Steam—Answers made by the majority of mining companies using Diesel or semi-Diesel engines would indicate that the low cost of the power produced by them, as compared with other kinds of power, was the dominant factor influencing their selection. Other factors entered in, especially where the mine plant is remote, but they appear subordinate to the question of power cost. As to whether the Diesel can compete with steam only where coal is expensive it is impossible to generalize. Reference to Table III shows that in those districts where coal is relatively expensive, fuel oil is also high. As to this point, Morrison and Kates, in the paper previously referred to, make interesting comment:[2] They say:



A Tri-State zinc company uses this Type C, 100-hp., horizontal, 2-cycle, semi-Diesel engine of Muncie make.

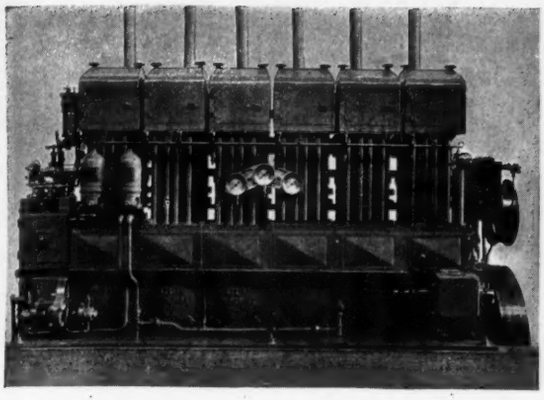
"Contrary to a popular misconception, the Diesel is not limited in its application to those localities where oil is cheap. Even in congested districts, such as the metropolitan district of New York City, the Diesel is the power source of many factories, in spite of the high oil prices existing along the Atlantic seaboard."

Elsewhere in the paper they say: "That the United States has been favored with an enormous oil supply is the basic reason for the wide application of the Diesel engine here. True, coal is likewise cheap, but due to high freight rates and the low efficiency of small- and medium-capacity steam plants, the Diesel has been found economically a good investment even in localities far removed from the oil fields. Even in



The Fairbanks-Morse Type Y, Style VA (now known as Model 32) 2-cycle, airless-injection Diesel engine, used by various mining companies. Until recently, this engine used two-stage combustion, now eliminated by employing an open-combustion chamber with a multiple-orifice spray nozzle, as illustrated. Fuel consumption has thus been improved about 10 per cent. Model 32 is made in two cylinder sizes rated at 55 and 70 hp. per cylinder.

[2]Another article, of value as a reference, is one by T. A. Burdick, entitled "Economics of the Use of Diesel Engines for Power Generation." *Power*, Sept. 16, 1930. See also "Diesel Power in the Canadian Mining Industry," by J. Ander, *Canadian Mining and Metallurgical Bulletin*, October, 1930.



This Atlas-Imperial 6-cylinder, 4-cycle, full-Diesel engine is the motive power of a 30-ton Plymouth locomotive, used by Calaveras Cement Company, San Francisco

Table III—Fuel Costs (Miscellaneous)

Locality	Fuel Oil	Coal
Arizona	$/Bbl. or c./lb	
Globe	$1.84 at plant	
Douglas	$1.47-$1.87	
Christmas	4.7c.	
Hillside	4.5c. at R.R. (+24)	
Patagonia	7.5c. f.o.b. mine	
Arkansas		
Cushman	$5.50 (kerosene)	$10
Batesville	3.75c	$10-12 (in carloads
California		
Sweetwater	2.9c. f.o.b. cars (stove oil)	$14
Laporte	12c. del. tank cars (fuel oil)	No coal
Nevada City	24 grav. oil, $0.86	$50
Florida		
Plant City	$2.30 (distillate)	
Georgia		
Hephzibah	10c. (fuel oil)	$6
Attapulgus	5c	$5.50
Idaho		
Lakeview	$3.78	$11.05
Idaho City	12c. del. (distillate)	
Baker	6c. (Salt Lake) 10c. (Baker) distillate	$12
Illinois		
Alton	7.3c. (Dist. 37-40)	$2.20
Kansas		
Medicine Lodge	$1.05	
Baxter Springs	(Gas, sliding scale)	$2.00 ack
Missouri		
Cadel	9c. (coal oil)	$3.35
De Soto	4.9c. (38-40 furnace oil)	$2.31 (short ton)
Joplin	4.5c. (fuel oil)	$5
Joplin	6.5c (dist. 34-40)	$2.50
Oklahoma		
Picher	4.8c (oil)	(Gas)
Michigan		
Saginaw	7.5c. (fuel oil)	
Iron Country	3.5-4c	
Montana		
Philipsburg	15.5c. (fuel oil)	
Nevada		
Beowawe	6c. (27+)	$12.50
Cortez	8.9c. (27+) 22.5c. (dist.)	$18.75
Kimberley	$2.50 (fuel oil)	$5-8
Betty O'Neal	$2.29 Battle Mtn (32+, 37+)	12.65
Lovelock	8c. (27 grav.) f. o.b. mine 28 miles from rail	$20
Tonopah	7c. (stove oil) (27-34 grav.)	$16
Eureka	16c. (dist.)	$14
Battle Mtn	Distillate	$9.50
Goodsprings	4.3c. (27+)	
Midas	9.6c. (32)	$21
Winnemucca	13c. (27+)	$28.50
New Hampshire		
Nashua	8c. (fuel oil)	$8 f.o.b quarry
Concord	6c	$7.50
New Mexico		
Fierro	4.09c	$7.10 (screened)
New York		
North River	6.9c. f. o. b. North Creek (28-32 grav.)	$5.60 North plus 10-mile haul
North Carolina		
Andrews	32.36c. (gas oil)	$3.50-$4.50
Hewitts	14.8c. (kerosene)	$4.25
Ohio		
Cincinnati	5.12½c. del (28-30 oil)	$2.25
Melvin	5c., gas oil	$3.74, egg
South Dakota		
Keystone	$3.15 (distillate, 38-40)	$5.10
Washington		
Index	7c. (oil)	$11

the midst of coal mining, oil engines are in service. In fact, certain coal mines use these engines for power.

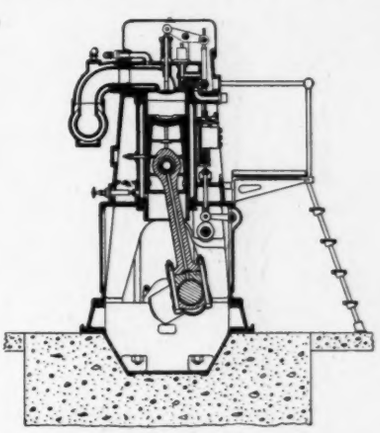
"Electrical companies when serving a dense population quite properly adhere to steam, for at existing fuel prices the larger steam plant has a generating cost below that of a Diesel plant, and in fact a few of the newer steam stations are delivering a kilowatt-hour for less than 14,000 B.t.u. With coal procurable at $2 per ton, this makes the fuel cost less than 1½ mills, and even for $6 coal, the ruling price in New York, the cost is 4.5 mills. For modern steam plants of large unit capacity a fuel cost of 3 mills is typical. This prevents the Diesel from becoming the prime mover of the large stations.

"On the other hand, most of the electrical companies serve districts by no means dense in population. Transmission losses are heavy and make the application of smaller Diesel plants placed at strategic locations sound economics. Consequently, many of the holding companies install units ranging from 4,000 hp. down to even 100 hp. An example of this type of engineering is the Louisiana-Texas Company, operating in Texas, New Mexico, and Arizona, which has over 20 Diesel plants.

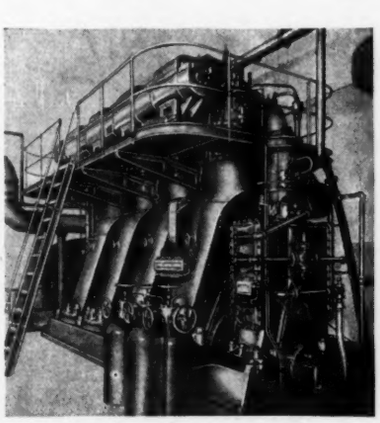
"Other companies install oil engines to carry a local load until the electrical demand becomes large enough to justify extension of the transmission line, whereupon the Diesel is moved to a newer and more thinly populated section.

"Of the 6,000 light plants in the United States, about 3,000 are municipally owned and over 3,200 are equipped with oil engines. Many of the municipal plants have been able to install these units by a savings payment plan, so that the increased plant earnings pay for the machinery."

Application—Of the total number of Diesel and semi-Diesel units (individual engines) covered by the survey, 69.8 per cent were said, by the mining companies reporting, to be used for generating power for general purposes; 12.3 per cent were used for driving compressors, either by direct-connection or through the medium of a generator; and the remainder, or 17.9 per cent, for driving other individual machines, such as hoists, pumps, fans (in emergencies) and, in a few cases, shovels and draglines.



Cross-sectional sketch of a Buckeye 4-cycle solid-injection Diesel engine. A 260-hp. 2-cycle unit of this make is installed at plant of Wenden Copper Company, Arizona.



Two Type 3-FJ Fulton Diesel engines, such as this, rated at 520 hp. at 164 r.p.m., were installed by Hanna Ore Mining Company, Iron Mountain, Mo., in 1923. They are 4-cycle air-injection. This type has since been superseded by the Type K.

Of the gasoline-driven engines, practically all were used for driving individual pieces of equipment, such as compressors, hoists, pumps, shovels, draglines, cranes, locomotives, tractors, crushers, screens, blowers, log washers, concrete mixers, ditch diggers, wire saws, small lighting plants, and as standbys for power purposes in emergencies.

Size of Units—The Diesel, semi-Diesel, and gasoline engines actually disclosed by the survey were grouped into classes according to their horsepower. The percentage of the total number of engines of each of the three types was then calculated for each class. No installations disclosed were excluded, save where the horsepower had not been divulged by the mining company giving the information. The resulting percentages are given in Table IV. Reference to this table shows that of the

Table IV—Size (Horsepower) of Diesel, Semi-Diesel and Gasoline Engines Disclosed by Survey

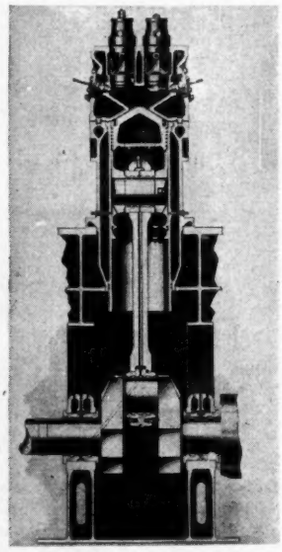
Expressed in Percentages of Total Number of Units (Engines) in Each Classification

Horsepower Class	Diesel	Semi-Diese	Total Diesel and Semi-Diesel	Gasoline
	Per Cent	Per Cent	Per Cent	Per Cent
1- 25	2.38	11.90	5.48	32.50
25- 50	3.34	17.80	8.05	48.75
50- 100	12.86	26.75	17.35	6.25
100- 200	21.40	25.72	22.80	11.75
200- 300	21.40	9.90	17.68	0.25
300- 400	9.05	7.93	8.69	.....
400- 500	5.26	.....	3.54	0.50
500- 600	2.86	.....	1.93	.....
600-1,000	6.20	.....	4.18	.....
1,000 and up (a)	15.25	.....	10.30	.....
	100.00	100.00	100.00	100.00

Note: (a) Includes installations of Phelps Dodge Corporation and Commerce Mining and Royalty Company among others

number of full-Diesel engines 55.66 per cent are between 50 and 300 hp. in size. Engines 1,000 hp. and over are 15.25 per cent of the total.

In contrast, the horsepower of semi-Diesel engines disclosed is concentrated in a lower range of sizes, the largest



Longitudinal cross-section of DeLaVergne Type VA solid-injection vertical Diesel engine, such as the two installed at plant of Attapulgus Clay Company, Attapulgus, Ga. The clay company's engines develop 400 and 660 hp. respectively.

unit reported being of 360 hp. Evidently, also, a larger proportion of semi-Diesel engines are under 50 hp. than is true of those of full-Diesel type. If both classes be grouped together, the percentage of engines ranging from 50 to 300 hp. is found to be 57.8, or approximately the same as in the case of the full Diesel.

As might be anticipated, the gasoline engines in service are of much smaller average size than the Diesel or semi-Diesel. Engines under 50 hp. constitute approximately 81 per cent of the total. All except three-quarters of 1 per cent are under 200 hp. Of course, some mining companies may be using gasoline engines that are larger than this, just as some may use semi-Diesel units of more than 360 hp., but the limits indicated are probably broadly correct for both classes.

Gas Engines and Natural Gas—With some exceptions, the gas engines disclosed by the survey were limited to the Tri-State zinc and lead district of Missouri, Kansas, and Oklahoma, where a few companies reported the use of a little more than 10,000 hp. Other than to include this horsepower in the total given in Table I, gas engines have thus far been given no consideration in this summary and analysis of the results of the investigation.

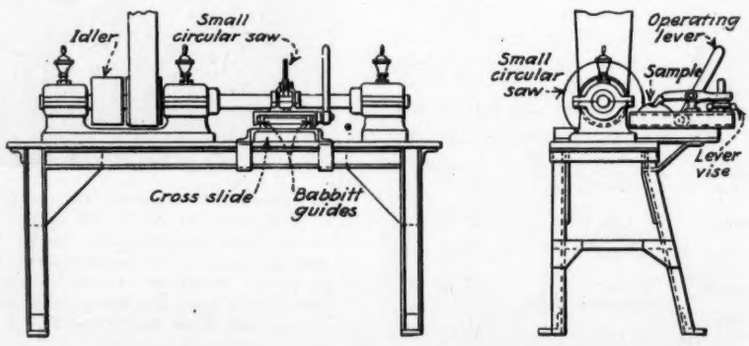
A change seems imminent, however. In the last two years, the consumption of natural gas in the United States has shown a tendency to increase greatly. Financial interests, to say nothing of state authorities, have at last seemingly awakened to the folly of permitting the enormous waste of gas to continue in the fields now producing. As a result, the year 1930 was marked by astonishing activity in pipe-line construction throughout the United States. This work has proceeded so rapidly, thanks to welding and other improvements in field methods, as well as to the impetus of the movement, that any computation of the total mileage has appeared antiquated and misleading within a month or two after it was made. It has been estimated that at least 9,000 miles of trunk lines alone were constructed during 1930 for conveying natural gas. Obviously, these lines have been located primarily so as to link up the great industrial centers with the sources of production. Some mining districts, at least, are nevertheless bound to profit, apparently, by having a new source of fuel and power thus brought within easy reach—and that within the next few years. Already a line is being run from fields in Texas into Douglas, Ariz., and it is reported that various Arizona camps are now looking forward to utilizing the new facilities. Likewise in Montana, arrangements have been made to bring natural gas to Butte and Anaconda from the Cutbank field. This expansion indicates the likelihood of a great increase in the use of gas engines in the not distant future. Already one mining company is said to be considering the possibility of making changes in its Diesel plant equipment that will permit the substitution of natural gas for oil as fuel.

■ ■ ■

Sample Cutting Machine

CUTTING COPPER samples in a lathe or power saw—a procedure performed daily at every smelter machine shop—is costly because of resultant rapid wear of the lathe gears, breaking of saw blades, and the non availability of the machines for more important work. Charles R. Clarkson, master mechanic at the American Smelting & Refining smelter at Hayden, Ariz., has overcome these difficulties by building an inexpensive machine for cutting samples exclusively, which is shown in the accompanying drawing. The machine, most parts of which were made of scrap material, is belt-driven and consists of the following parts:

A main frame made of 4-in. channel iron, reinforced with 2½-in. angle iron and ⅜-in. plate; a home-made hand-operated cross slide, constructed entirely of 10- and 8-in. channels, with its babbitt guides and lever vise; two pulleys (drive and idler); a steel spindle with an attached small circular saw; and the rear, front, and tailstock bearings. The design of the lever vise and the method of moving the cross slide, accomplished by an attached lever mechanism, are of particular interest, as both features, because of their simplicity, considerably expedite cutting operations.



MEAN EFFECTIVE PRESSURE CHART

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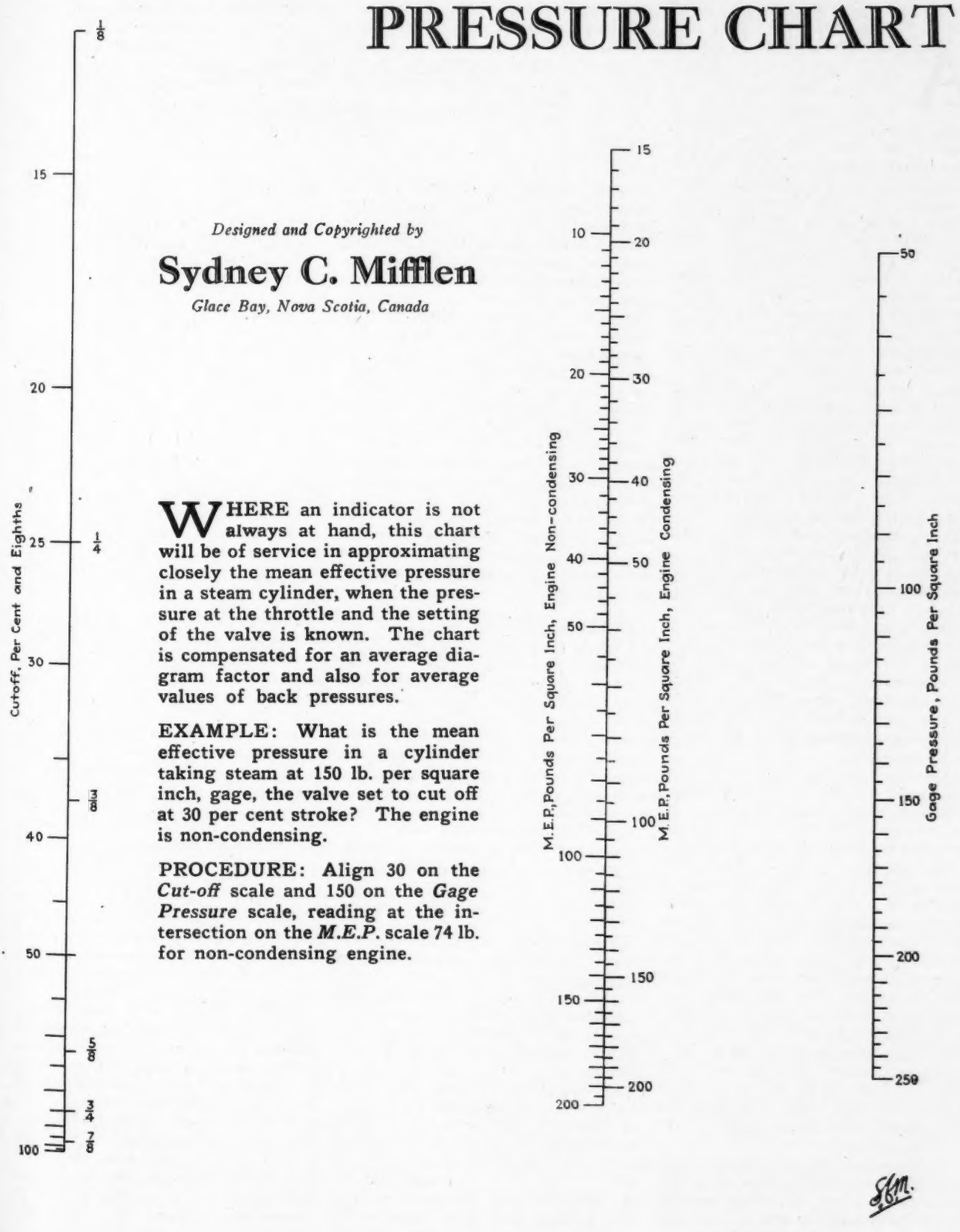
Sydney C. Mifflen

Glace Bay, Nova Scotia, Canada



WHERE an indicator is not always at hand, this chart will be of service in approximating closely the mean effective pressure in a steam cylinder, when the pressure at the throttle and the setting of the valve is known. The chart is compensated for an average diagram factor and also for average values of back pressures.

EXAMPLE: What is the mean effective pressure in a cylinder taking steam at 150 lb. per square inch, gage, the valve set to cut off at 30 per cent stroke? The engine is non-condensing.

PROCEDURE: Align 30 on the *Cut-off* scale and 150 on the *Gage Pressure* scale, reading at the intersection on the *M.E.P.* scale 74 lb. for non-condensing engine.

Geology of the Pecos Mine

Charles E. Stott

Mining Engineer, American Metal Company, Ltd., El Paso, Tex.

ABOUT 18 miles northeast of Santa Fe., in New Mexico, and in the northeastern corner of San Miguel County, 13 miles north of the town of Pecos, is situated the Pecos mine of the American Metal Company of New Mexico, a subsidiary of the American Metal Company, Ltd. The property is in the Pecon Canyon at the junction of the Pecos River and Willow Creek. Camp and postoffice are known as Tererro.

Messrs. Lindgren and Graton visited this district in 1905, and their report, published in Professional Paper No. 68 of the U. S. Geological Survey, briefly describes the geology and ore occurrence of this mine. A more detailed description of the geology, in an article by A. H. Hubbell, appeared in the Dec. 25, 1926, issue of *Engineering and Mining Journal*. At the time the first report was written, the mine, then known as the Hamilton or Cowles mine of the Pecos River Mining Company, was little more than a prospect with a 180-ft. shaft and a short adit tunnel. In 1920, Basil Prescott examined the property, and his report of the geology was incorporated into Mr. Hubbell's article. Numerous other reports of a private nature have been made, none of which have been published. Recently, the U. S. Bureau of Mines published a complete paper, by J. T. Matson and Clifford Hoag, which gives in detail the mining methods and costs at the Pecos mine, together with a description of the orebodies.

The first important development work was done by the Goodrich-Lockhart Company, which took an option on the property in 1916, and carried out an intensive diamond-drilling and development campaign. American Metal Company of New Mexico took the property over in 1925, and, in addition to equipping it and putting it on a production basis, has continued, since then, to explore the mine systematically and develop it at depth and along the strike. The main shaft has been sunk to a point 30 ft. below the 1,000 level, which is actually 930 ft. below the collar, and levels have been opened at 100-ft. intervals down to and including the 1,000 level. About 38,000 ft. of diamond drilling has been done, including both underground work and prospect drilling from the surface.

In describing the geology and ore deposits of the Pecos mine, I do not consider it within the scope of this article to attempt to take up in detail the various rock-forming processes, nor to discuss at any great length the many interesting and complex phases which are brought out by a microscopic examination of the rock minerals. Philip Krieger, of the department of geology of Columbia University, recently spent several months at the mine, gathering data for a paper which will appear in one of the geological publications sometime within the coming year. Mr. Krieger's microscopic study of the various rocks and ore-mineral relationships, together with his field observations, will undoubtedly clear up many important and interesting points which have long been matters of doubt to those who have tried to solve the more complex side of the Pecos ore deposits. In this connection, I wish to acknowledge my appreciation of the many helpful suggestions offered by Mr. Krieger, and to thank Messrs. Van Dyne Howbert, J. T. Matson, and M. W. Hayward for their assistance and co-operation both in the field work and in reviewing this article.

THE zinc-lead ore deposits of the Pecos mine occur as lens-shaped orebodies in sheared and schistose intrusive rocks of Pre-Cambrian age. The Pre-Cambrian forms the basal rock upon which have been deposited some 1,000 to 1,200 ft. of limestones, sandstones, and shales of Carboniferous age. The beds dip about 12 deg. southwest, and extend over the entire area for several miles in each direction. Only where the beds have been deeply cut by the Pecos River and its tributaries can the old Pre-Cambrian surface be seen. This condition, of course, adds greatly to the problem of making extensive correlations of the Pre-Cambrian based on surface observations. The overlying sedimentary beds were deposited on the eroded surface of the Pre-Cambrian long after the completion of the ore-forming processes, and for this reason they are of only slight economic importance in considering the geology of the earlier Pre-Cambrian ore deposits. Of course, any distinct faulting of the Carboniferous capping in the vicinity of the mine would indicate a post-mineral faulting in the Pre-Cambrian, with the possibility that the orebodies would be cut off and displaced; however, no important faults have been found in the sedimentaries which would indicate such a condition. Therefore, a lengthy description of the sedimentaries would not be of material interest.

AS EXPOSED on the surface near the mine and underground, the Pre-Cambrian rocks represent at least two separate intrusive periods, both of which occurred after, and invaded an earlier, dark-green, medium- to fine-grained rock which was formerly called a diorite but is now classified as a diabase. As will be discussed later, some evidence exists that the diabase itself represents an early intrusion of an original rock mass whose boundaries and identity have been destroyed by metamorphism and silicification. The diabase forms the greater part of the country rock within the immediate mine area, and is fairly resistant to weathering processes. It grades from a dark-green, very fine-grained, dense variety, usually highly silicified, to a coarser-grained type somewhat lighter in color. Both types have been subjected to strong dynamic stresses and later silicification.

Although the schistose texture of the rock cannot always be seen in the hand specimens, microscopic examination reveals that the diabase is, for the most part, a finely laminated, compact schist which has been recemented and sealed by the addition of later quartz, and thus presents at times a very massive and dense appearance. The foregoing is especially true of the fine-grained type occurring within the vicinity of the mine. The true schistose texture of the rock can plainly be seen in hand specimens of the coarser-grained type In the latter, a typical amphibolite schist has been developed, which makes up the larger masses outcropping to the east of the mine in Willow Creek and Davis canyons. The amphibolite schists occasionally show a granular, compact rock resembling a granodiorite.

On first inspection it would appear that the diabase is made up of several different intrusives. However, lack of definite contacts and the gradual change in texture from one to the other lead me to believe that this rock mass represents one intrusive period which has been differently subjected to dynamic stresses and later igneous invasion. To sum up the foregoing description, the rock, which will be called a diabase in this article, is primarily a schistose rock made up of plagioclase, amphibole, biotite, some pyroxene, and smaller amounts of zircon, apatite, and rutile. Metamorphic minerals, such as actin-

olite and garnet, are also present. Alteration of the amphiboles to biotite and chlorite is commonly seen, along with the formation of considerable sericite in the more schistose varieties. Quartz and tourmaline are present as later introduced minerals.

In turn, the diabase has been intruded by a more acid rock which shows the general characteristics of a granite. As shown in Fig. 1, the granite occurs over a wide area east of the mine, and its contact with the diabase is fairly well marked. In appearance, it is light-colored, generally gray to light pink, and its texture is medium coarse-grained to aplitic. Quartz is the predominant mineral, and is associated with orthoclase and some plagioclase feldspar. As in the diabase, the granite shows gradations in texture, and likewise has been subjected to dynamic metamorphism. Sheared and schistose areas occur within it. These areas have undergone considerable erosion on the surface, and are largely covered by wash. The more massive type of granitic rock forms prominent cliffs in Willow Creek Canyon. The granitic rock is not exposed in its original state within the mine workings. It is apparent that it was much more susceptible to shearing processes than the diabase, and, because of this fact, I believe that its original texture was destroyed in the formation of the zones of quartz sericite schist and talc schist that occur within the main shear zone at the mine.

The surface map (Fig. 1) shows several dike-like occurrences of the diabase within the granite area. These formerly were thought to be diabase dikes cutting the granite. By platting the contacts cut by the mine workings and drill holes, the diabase also was shown to occur along trends that suggested later dikes following the direction of the shearing. However, additional mapping of the geologic details, both underground and on the surface, has brought out the fact that the diabase is unquestionably the older rock, and that the occurrences within the granitic area are in the form of remnants which, in some instances, occur as isolated blocks supported and entirely surrounded by the later granitic rock. Usually, these blocks or horses of diabase are of the fine-grained, dense-appearing variety, strongly silicified. In some instances they have been subjected to later shearing stresses, and occur as bands of chlorite and biotite schist alternating with bands of quartz sericite schist of granitic origin. As will be pointed out in discussing the structural conditions, these remnant blocks of diabase have had considerable bearing on the resultant direction of the shearing and the continuity of the orebodies. Additional evidence that the diabase is the older rock was furnished by Krieger, who found several boulders made up of angular fragments of diabase held together by a matrix of quartz sericite schist, the diabase fragments themselves containing numerous quartz veinlets.

SOME commentators have suggested that regionally the diabase could be described as being a roof pendant in the granite. Though this might be so, there is no definite proof of such a condition at the Pecos mine. The small remnant blocks described in the foregoing are the only examples that could be used in coming to such a conclusion at this time. In describing the regional geology as exposed in the vicinity of the mine, the term "regional gneiss" appears applicable.

The last phase of igneous activity in this district apparently has been the intrusion of pegmatites in the form of dikes 2 to 50 ft. or more in width, which have invaded the diabase, granite, and schist. At times the dikes followed the strike of the shearing, where they were apparently controlled, in some degree, by the more open schist zones. At these places the schist apparently has been twisted and pushed aside by the pegmatite. In other instances the pegmatite dikes cut sharply across the schistose rocks. The wider dikes are made up of large crystals of quartz, orthoclase, and muscovite, and represent a typical pegmatite in both composition and texture. The narrower occurrences, especially stringers a few inches wide, are of a coarse granitic texture.

Some of the white quartz stringers, which appear to be later than both the diabase and the granite, are evidently associated with the pegmatitic phase. The typical pegmatite described is not found within the mine workings. However, a few occurrences of the narrow stringer type have been identified in one or two of the long crosscuts and drill holes outside of the mineralized shear zones. The true pegmatite dikes outcrop prominently about 2½ miles north of the mine in Pecos River canyon. Small dikes and stringers have been cut in drill holes to the east within 1,200 ft. of the mine.

Although numerous quartz stringers appear to belong to the pegmatitic or end-phase stage of the igneous activity, the general silicification of the diabase is considered to be closely associated with the granite intrusive period. The presence within the mine of comparatively wide zones of quartz sericite schist, which grades into a highly siliceous diabase of schistose texture, indicates that the introduction of the quartz occurred after the primary shearing of the diabase, and, as mentioned previously, resulted in the cementation of the schistose diabase. The course of the invading acid intrusive was controlled largely by the original structural conditions within the diabase.

Probably, large areas of quartz seri-

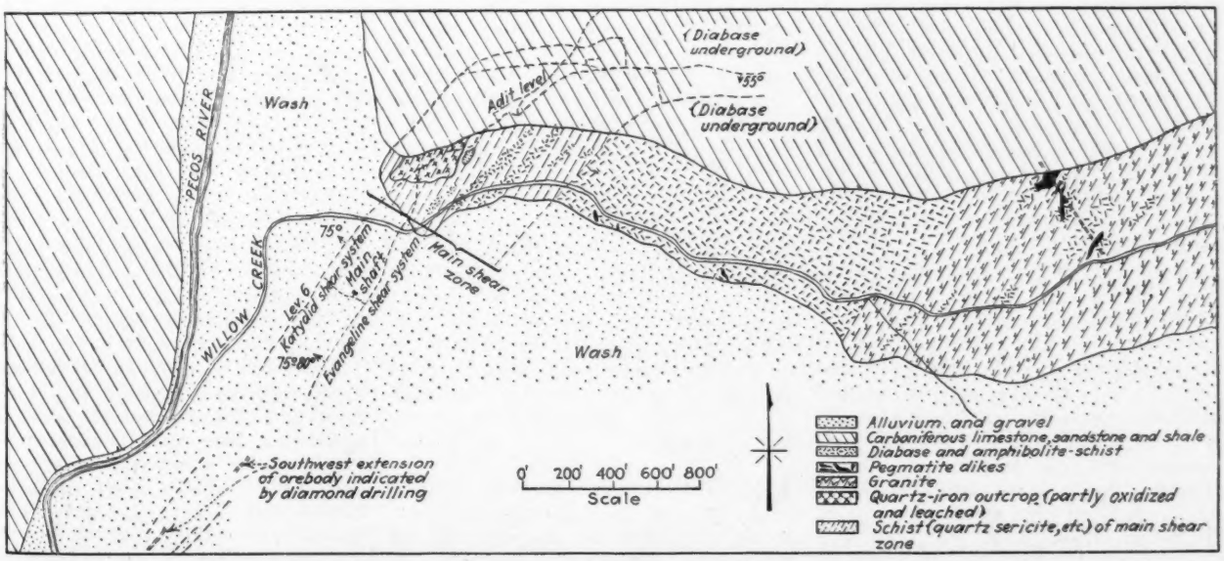


Fig. 1—Surface geologic map (Willow Creek) of Pecos mine

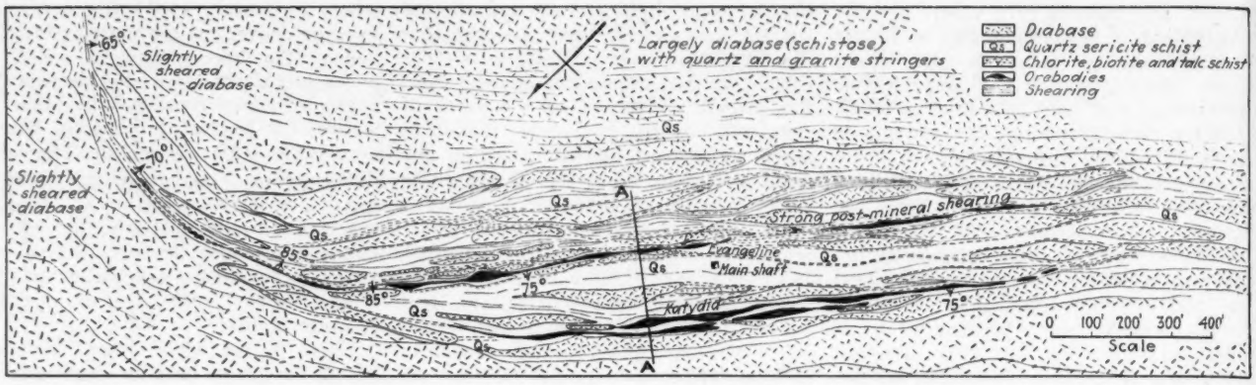


Fig. 2—Geologic plan of Pecos mine, showing shear zones and orebodies

cite schist represent granite intrusions into the initial shear zones opened up in the host rock. The quartz-iron outcrops immediately above the mineralized shear zones are highly siliceous. Although weathering, with consequent surface silicification, has given the outcrops the appearance of being massive quartzose rock, this fact is but added proof of the high silica content in the rocks of the main shear zones. This characteristic is lacking in other outcropping rocks beyond the limits of the known mineralized area. Silicification is shown in some degree throughout all of the diabase; however, there appears to be a concentration of introduced quartz within the limits referred to above. Hence the silicification of the diabase and the formation of areas of quartz sericite schist may reasonably be assumed to represent the results of an acid segregation of the granitic phase whose invasion of the diabase was confined chiefly within the structural limits which define the main zone of shearing.

STRUCTURAL conditions, similar to those in other districts which have undergone like dynamic metamorphism and readjustment, present many features of economic importance. Not only are the mining and development methods dependent on the structure, but also the size, shape, continuity, and grade of the orebodies. For this reason, a close study of the structure of the shearing is necessary, and the engineers concerned have considered advisable the making of plans of each level, and frequent cross-sections as well, showing the geologic details.

The term "main shear zone" has been applied to the schistose rocks which apparently represent the zone of maximum shearing. Although all of the Pre-Cambrian rocks exposed in this district are more or less schistose, and indicate a regional shearing, the results of dynamic metamorphism and readjustment are not elsewhere so highly pronounced, nor as strongly defined, as they are along the shear zone under discussion. The total width of this zone is probably not more than 600 ft. at the widest point. The shearing has an average strike of about N. 40 deg. E., conforming to the general orientation of the regional shearing. General dip is from 70 to 85 deg. to the northwest in the upper 500 ft. of the mine. The lower levels (below the 6th) show strong dips to the southeast.

Locally, there are many variations in strike and dip. At a point about 1,500 ft. northeast of the main shaft, the shearing changes from its usual northeast strike to almost due east, and has been followed on the adit level for over 800 ft. in this direction. In making this change in strike, the shearing also makes a reversal in dip, changing to a south dip of about 55 deg. Fig. 1 shows the relative positions of the underground workings and the outcropping rocks. As may be noted, the main shear zone, in turning to the east, becomes narrower. It is apparently squeezed between two large masses of relatively unsheared diabase. The fact that this condition exists is well shown in the adit level drift to the east, where the shearing is very "tight" in appearance and where little or no true schist has been developed. Diamond drilling has shown that there are large areas of dense unsheared diabase to the north and south of this drift. Underground development and prospect drill holes southwest of the shaft have proved that the shearing continues on its normal strike for at least a mile. The total width of the shear zone is not known at all points. A tendency to narrow and bulge along the strike is evident, and especially so when the strike of the shearing changes from its normal direction.

In detail, the main shear zone is made up of bands of quartz sericite schist and horses of silicified diabase which alternate with bands of talc, chlorite, and biotite schists. The blocks of slightly sheared to massive silicified diabase are often separated from each other and from the schist by several feet of gouge.

WITHIN this schistose complex are the two mineralized shear zones containing the Katydid and the Evangeline orebodies. In plan, as shown in Fig. 2, these two systems parallel each other for over 800 ft. along the strike of the shearing. The Katydid is gradually converging with the Evangeline at a point about 700 ft. northeast of the main shaft. The Evangeline continues farther to the northeast beyond here, and eventually turns, following the shearing to the east. Although both orebodies occur under similar conditions and resemble each other in many respects, each one represents a distinct structural line or system within the main shear zone.

Fig. 2 shows a plan view of the Katydid and Evangeline orebodies, and a correlation of the geologic features that have been mapped in detail. In each system, as is apparent, the individual orebodies taper at the ends to mere stringers of mineralization which, in turn, swell to good widths elsewhere along the strike. Occasionally, these stringers disappear entirely, and the next body is found slightly to one side and overlapping the other. At times an orebody is cut off abruptly by a block of dense, fine-grained diabase. In these circumstances the schist or shearing is seen to have tightened and made a sharp change in direction, and it can be followed around the block of diabase, where it will again assume its normal strike. The ore often pinches out at these points where the schist turns, and similarly may be picked up again when the strike becomes normal. Under other conditions the diabase block has had the same effect as a wedge, and the shearing splits and continues around each side, leaving a block or horse of diabase within the orebody. To find the diabase partly replaced by the ore minerals is not unusual, and occasionally this replacement may be so complete that the original diabase can be recognized only by the structural appearance[1] of the ore.

Unsheared blocks or remnants of diabase generally show a rounded surface, and oftentimes are lens-shaped with their long axes oriented to conform to the prevailing strike of the shearing. Uusually, their surfaces are coated with a very thin layer of soft

[1]Jointing at right angles to the schistose texture of the diabase has given it a characteristic "blocky" appearance.

talc or chlorite schist, but in some instances the surrounding rock or ore makes a clean, sharp contact with the dense, fine-grained diabase. The unsheared blocks of diabase occur within other minor lines of shearing, and in each example noted their effect has been the same—namely, to cause sharp changes in the direction of the shearing.

BY REFERENCE again to Fig. 2, the reader will note that wide bands of schist occur either within or along the walls of the Evangeline orebody. Considerable strike movement or post-mineral shearing is also indicated at several points along the strike of this orebody. The surfaces of these strike faults show strong slickensides, which pitch from 10 to 30 deg. to the southwest and occasionally are horizontal. Under most conditions noted the fault surfaces show that the southeast wall has moved slightly up and to the northeast with respect to the northwest wall. The total amount of movement or shift is not known, and would be very difficult to determine; it is probably divided over a series of planes across the width of the Evangeline shearing.

Considerable gouge has been formed along the planes of movement, and fragments of drag ore are often found embedded in the gouge, thus indicating that the movement is post-mineral. In fact, the general effect of this post-mineral shearing has been to break up the Evangeline orebodies into stringers of ore and waste rock, which necessarily adds greatly to the problem of mining and sorting. Post-mineral shearing is particularly pronounced in the Evangeline orebodies on the lower levels. The Katydid, on the other hand, has not undergone any great amount of post-mineral shearing. As a rule, the walls of this orebody are well defined. The ore is cleaner, more massive, and can be mined with less dilution. Shearing can be seen, but is not so pronounced nor so open as on the Evangeline side.

Although stringers of ore, which sometimes are of minable width, occur paralleling both of the orebodies, those of the Evangeline are generally found to be sheared or faulted sections from the side of the main orebody, whereas those of the Katydid appear to be in their original positions. Another interesting and important fact is that the Katydid shear zone acts as a reservoir for the accumulation of surface waters. Drill holes which crosscut the Katydid shearing usually show water pressures which are in rough proportion to the depth at which the shearing is encountered. There is considerable water in the Evangeline shear zone, but it is not found to occur in large flows or under any appreciable head, and generally seeps away through the more open and fractured rocks that characterize this system.

Fig. 3 is a cross-section at right angles to the shearing. From this the fact is apparent that a striking resemblance exists between structural conditions in both plan and cross-section, and that certain characteristics which have been discussed in the foregoing in plan also apply in considering the downward extension of the shear zones and orebodies.

That sudden changes in the strike of the shearing or schistosity can in most cases be traced to the presence of a block or horse of hard, unsheared diabase which has resisted the major shearing stresses and has caused a local tightening of the shearing, and a resultant decrease or pinching out of the mineralization has already been noted. Although the major dynamic stresses are considered to have resulted mainly in nearly horizontal movement (very slight) along the direction of the shearing, the effect of the more resistant blocks of diabase, when viewed in cross-section, has been much the same as is seen in plan. Abrupt changes in either the strike or the dip of the shearing are generally accompanied by a tightening of the rock and a decrease of the ore cross-section.

Another point which Fig. 3 brings out is that, although the Katydid orebody, to the lowest horizon developed, maintains the same general dip to the northwest, the Evangeline shows occasional reversals.

A longitudinal section of the mine shows that as each successive lower level on the Evangeline side is developed to the northeast, the orebodies are found to terminate at a decreasing distance in this direction, thus showing a plunge or rake to the southwest which varies between 30 and 50 deg. The change of strike and reversal of dip of the shearing further to the northeast, conforms to this general south rake. The rake to the southwest is not so well shown at the northeast end of the Katydid orebody. However, the angle made by the junction of the Evangeline and Katydid shear zones and orebodies forms a trough that likewise plunges at varying degrees of dip to the southwest. Although there is some suggestion of a similar plunge

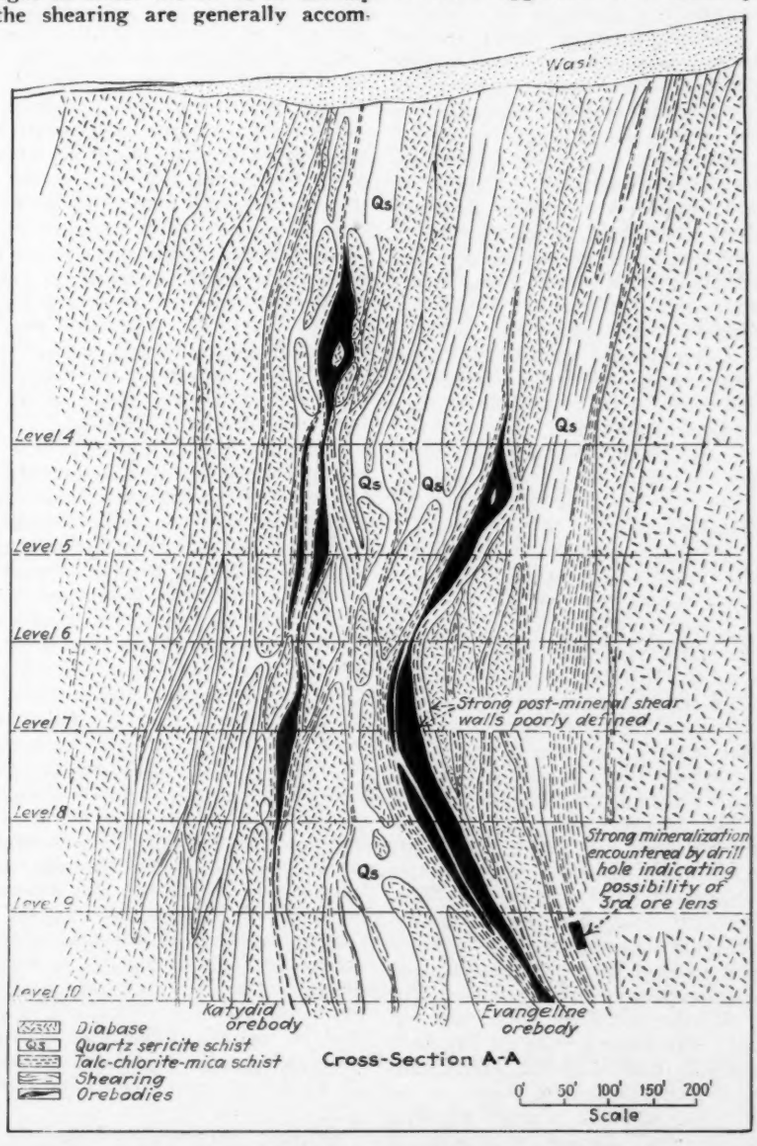


Fig. 3—Cross-section of Pecos mine, along A-A, Fig. 2

at the southwest ends of the main orebodies, it is not marked with the same regularity as is shown at their northeast ends, and development of the lower levels toward the southwest has not proceeded far enough to outline the extremities of the orebodies definitely in this direction.

OREBODIES of the Katydid and the Evangeline shear zones represent a primary mineralization which appears to be closely associated with the general silicification of the schistose rocks. The ore-minerals consist essentially of pyrite, sphalerite, galena, and chalcopyrite. An appreciable amount of gold and silver is present. The silver is evidently associated with the galena. The gold has not been found to be definitely associated with any particular ore mineral.

Polished sections of ore specimens, when examined microscopically, show an intimate mixture of pyrite and sphalerite, with smaller amounts of galena. In all of these the sphalerite and galena are shown to be replacing the pyrite. Remnant inclusions of pyrite are frequently seen within the sphalerite, and in many instances the pyrite inclusions can be recognized as former cubes whose edges and corners have been practically obliterated by the other two minerals. The galena, in turn, appears to be later than the sphalerite, and can be seen replacing both the sphalerite and the pyrite. The chalcopyrite, which occurs in scattered amounts and often associated with stringers of white quartz, was evidently the last ore mineral introduced. Where it occurs with the pyrite, sphalerite, or galena, it invariably can be seen replacing these minerals.

I have not made an exhaustive study of the ore minerals, and will not attempt to discuss the more detailed relationships that are shown by them. Guy V. Martin, formerly chief chemist at the Pecos concentrator, has done considerable research on the ores and concentrates, and by using high-power magnification has identified such minerals as marmatite, bornite, argentite, tetrahedrite, and proustite, mostly as very minute occurrences. The additional research on these ores which Mr. Martin is now doing at the Missouri School of Mines, together with Mr. Krieger's study of the minerals, will show, no doubt, that many more complex phases are represented in the mineral relationships than have been briefly outlined in the foregoing.

Sphalerite and chalcopyrite are seen only in massive form. The pyrite, and to a lesser degree the galena, occur both in the massive form and as crystals. Massive pyrrhotite has been found associated with the other minerals at a few scattered places in the mine. Although its mineral sequence is not definitely known, it appears to be later than the pyrite.

GRADE of ore mined during the past three years of operation has averaged 16.06 per cent Zn, 3.73 per cent Pb, 1.02 per cent Cu, 3.39 oz. Ag, and 0.109 oz. Au per ton. Some evidences of an increase in the lead content are found in the Evangeline stopes below the 700 level. However, sufficient depth has probably not been attained to indicate that this increase could be attributed to a zoning of the ore minerals. The Evangeline zone shows the results of strong shearing and post-mineral movement to a greater degree on the four lowest levels than it does above. A part of this shearing evidently represents recurrent movement which took place during the period of mineralization. Dr. Charles P. Berkey[2], of the department of geology of Columbia University, noted that "the ore minerals show fracturing and rehealing with the addition of metallic minerals after the period of deposition. . . ." I have noted this condition in various ore specimens, and that the chalcopyrite and certain crystals of galena, which occur together with stringers of white quartz in the lower part of the Evangeline shear zone, were formed after the main period of ore deposition, is apparent. Hence, the zones which have undergone later shearing movements might be found to have the higher lead and copper assays. Although unusually high lead and copper values are occasionally met in the lower Evangeline stopes, no evidence at hand suggests a general large increase in either metal in this part of the mine. The later lead and the chalcopyrite appear to be represented, for the most part, by isolated stringers which only locally affect certain sections of the orebody.

Structural conditions and rock texture undoubtedly have been the controlling factors which governed the size, shape, and grade of the Pecos ore deposits. Thermodynamic metamorphism of the diabase may have resulted in the formation of certain metamorphic minerals which favored replacement by the ore minerals, as where, apparently, the former blocks of dense, fine-grained diabase have been completely replaced by ore. However, I do not consider such examples of apparent replacement to represent an ore-forming process that could be applied to the formation of the ore deposit as a whole. The finely schistose, hard diabase has resisted not only later shearing action, but also mineralization, and, in general, only where blocks or horses of this rock occur in zones of strong mineralization are they found to be replaced by ore. The ore, thus formed, usually has a massive appearance, and is granular in texture, rather than schistose; nevertheless, the occasional occurrence of bands of ore conforming to the schistosity of the diabase is evidence that openings, afforded by the schistose texture of the rock, favored its mineralization rather than the presence of replaceable minerals.

Stream erosion of the Pre-Cambrian surface in Willow Creek Canyon has exposed several mineralized outcrops within the main shear zone. However, available evidence suggests that the main orebodies pinched out before reaching the old Pre-Cambrian surface. As the northeast extension of the Evangeline orebody was followed upward from the adit level, the orebody ended 30 to 50 ft. below the contact of the Pre-Cambrian with the overlying Carboniferous beds. Considerable drifting has been done immediately along the contact, above the highest points of the orebody, and, although the shear zone continues to the top of the Pre-Cambrian, no upward extension of the orebody has been found. Oxidation has affected only the upper parts of the orebodies near the surface. At these a few scattered occurrences of such minerals as smithsonite, anglesite, and cerussite, together with some malachite, chrysocolla, and chalcanthite, have been noted. No secondary enrichment has been observed, except in the upper stopes, where chalcocite is sometimes seen in minute particles coating the other sulphides.

SEVERAL important factors, described in the foregoing, characterize the geology of the Pecos ore deposits. Of first importance is the fact that the Katydid and Evangeline orebodies are confined to shear zones which evidently were controlled in their direction, dip, and width by blocks of relatively hard, massive diabase which resisted the shearing stresses. This condition, which can be seen locally throughout the individual shear zones, also applies on a larger scale to the main zone of shearing. Hence, to assume that the major shear zones represent later shearing movements which were controlled largely by and followed granitic intrusions along initial lines of fracturing or shearing within the diabase, is logical. This fact is well brought out at the northeast end of the mine, where, as previously described, the shearing makes a marked change in its direction and dip, with the result that the northeastern extension of the Evangeline orebodies pinches out as the shearing turns from northeast to east. In the foregoing instance large areas of resistant diabase have opposed the prevailing direction of the shearing stresses. In many instances the diabase has yielded to the directed movement, and has broken or sheared. In others the shearing, deflected from its normal direction, has passed around the block of diabase to open up and resume its former course.

The Katydid shear zone, which has undergone less shearing movement than

[2]Private petrographic report by Dr. Berkey on the rocks and ores of the Pecos mine.

the Evangeline, possesses several characteristics which give it the appearance of having been an original line of shearing or fracturing in the diabase. The Evangeline, however, evidently represents the principal line of later shearing movement which followed the initial stresses. This structural difference in the two shear zones, together with the fact that diamond drilling has encountered mineralization and strong shearing to the southeast of the Evangeline, indicates that the chances of developing new orebodies, by crosscutting in this direction, are more favorable than by prospecting to the northwest from the Katydid side, where a large block of resistant diabase is known to exist.

The Katydid has not been fully developed on the four lower levels, and very little can be said regarding its future possibilities for downward extension. The Evangeline, however, shows strong shearing and mineralization on the lowest developed levels, and, although it shows erratic dips and changes in cross-section, it is evident that this orebody will persist with depth. Drilling from the surface has proved that the Evangeline orebody extends downward and to the southwest for a considerable distance below the present mine workings.

Another important factor is that the formation of the ore deposits appears to be definitely associated with the general silicification of the rocks of the main shear zone. Although the genetic relationship between the silicification and the ore deposition has not been definitely established, the importance of this association lies in the fact that it may be used as a guide in prospecting other shear zones and areas beyond the known mineralized limits.

■ ■ ■

Tailing Disposal Innovations

AMPLE GRADE avoids trouble in the conveyance of tailing by launder, writes William Crocker, of Prescott, Ariz., but such provision is not always practicable.

Fig. 1 illustrates the tailing dam of the Sheldon mine, Yavapai County, Ariz. The line *AB* represents the face of the dam, the line *ABC* the back shore line, and the double line *DE* the distributing launder. The launder *DE* is longer than the distance from *A* to *C*. When this is the case, and the launder has a grade greater or even slightly less than the grade the tailing will take in the dam, the sump of the dam, which, for safety, should be near *C*, forms near the lower part of the launder at *E*. With the heavy winter storms soaking the face of the dam, the dam tends to break at that point. At the Sheldon mine this danger was avoided by using a pipe, arranged as in Fig. 2, instead of the usual wooden launder. Less grade is thereby necessary.

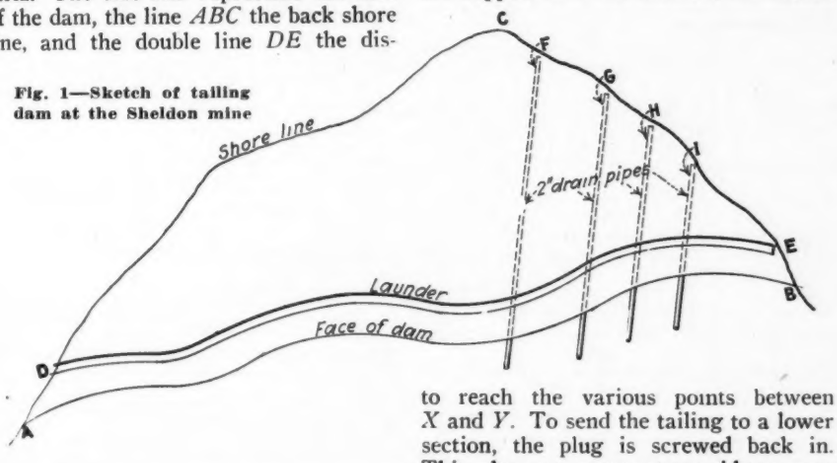
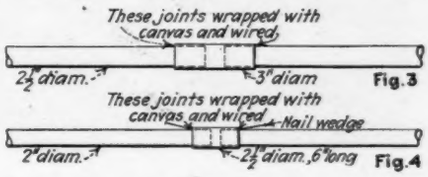


Fig. 1—Sketch of tailing dam at the Sheldon mine

To distribute tailing between *X* and *Y*, a section along the dam face, plug *A* is screwed out and a nipple substituted. The momentum carries the tailing through this nipple without any of it passing laterally through the ell. Then sections of 2½-in. pipe, 10 ft. long, with sleeves made of 3-in. pipe on one end, are slipped over one another, as needed, to reach the various points between *X* and *Y*. To send the tailing to a lower section, the plug is screwed back in. This plug arrangement provides a perfect stop and drain valve that is exceedingly simple and foolproof.

When the dam man leaves at night, a bent 3-in. pipe projecting out into the dam, as at *D*, is slipped over nipple *B*, and over *D* is slipped a 4-in. spiral pipe 12 ft. long. This will easily distribute tailing for one night. A slightly longer piece of pipe has distributed tailing for days without changing. The sections between the ells and tees are, as Fig. 2 indicates, about 60 ft. long. This length was found sufficient to prevent slime being pocketed near the face of the dam by the conical piles of tailing at the end of the spiral pipe.

Instead of the usual threaded coupling being used in putting the pipe together, a piece of 3-in. pipe, 6 or 7 in. long, was slipped over the ends, as in Fig. 3. When the joints are well wrapped and wired, the space between the 3-in. sleeve and the 2½-in. pipe soon fills with tailing, making a leak-proof joint. This joint is easily assembled and has a long life. By turning the pipe from time to time it is worn equally all around. This can be done without stopping the flow of tailing.



Figs. 3 and 4—Special pipe joints employed

Another useful detail was that used in draining the clear water off the dam. In Fig. 1, *F*, *G*, *H*, and *I* represent drain pipes under the dam. If the point *C* were three or four times further back from the face of the dam, only one pipe would be necessary to drain the clear water. But in a dam shaped as in Fig. 1, three or four pipes at intervals along the shore *CB* are necessary to keep the water as low as possible. Pipe 2 in. in diameter was found to be better than larger pipe. This size, by not draining the water off too fast, automatically maintains an area sufficient to settle out all the tailing. The pipe used for these drains was scrap, most of it so thin that it could not be threaded.

Splits and holes in the pipe were wrapped with canvas and wired. The pipe was put together with sleeves made from 2½-in. pipe, as in Fig. 4. This arrangement gave a continuous supply of clear water.

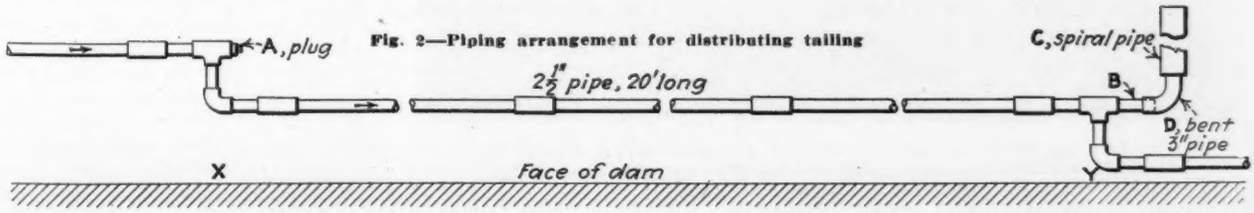


Fig. 2—Piping arrangement for distributing tailing

Mine Filling Practice in Germany

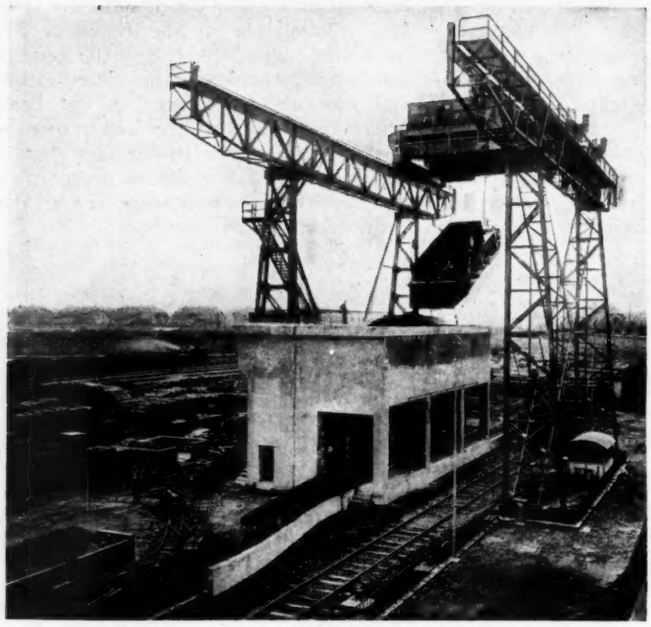


Fig. 1—Tipping plant for transferring filling from railroad cars to mine cars

Highly mechanized operations characterize methods of handling material sent underground to refill stopes

Hans F. Kutschbach

Berlin, Germany

If electric power cannot be obtained the shovel is operated with a steam engine, or a Diesel or other type of internal-combustion engine.

POWER SHOVELS are used extensively in Germany for loading cars with waste rock, slag, gravel, or sand employed as mine-filling material. The shovel usually travels on a continuous tread, so that it can approach the workings from all sides and move on rough or uneven ground without having to depend on rails. Electricity, if available on the site, is the most convenient source of power for the operation of the shovel; and flexible cables, adequately armored and laid along the ground, transmit the current.

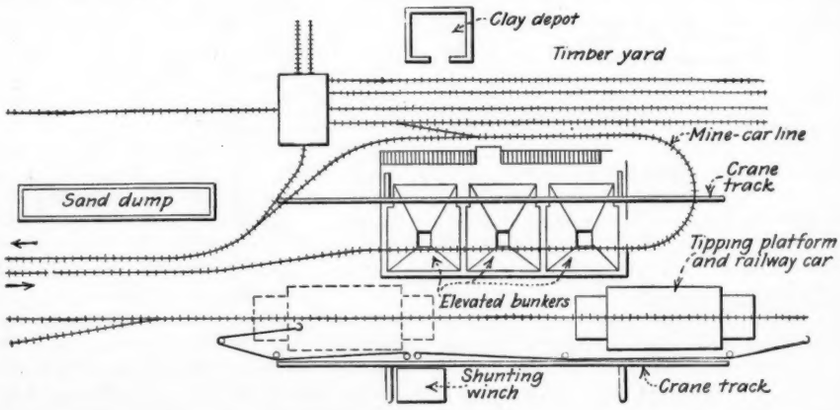


Fig. 2—General plan of mine-filling plant. See Fig. 1.

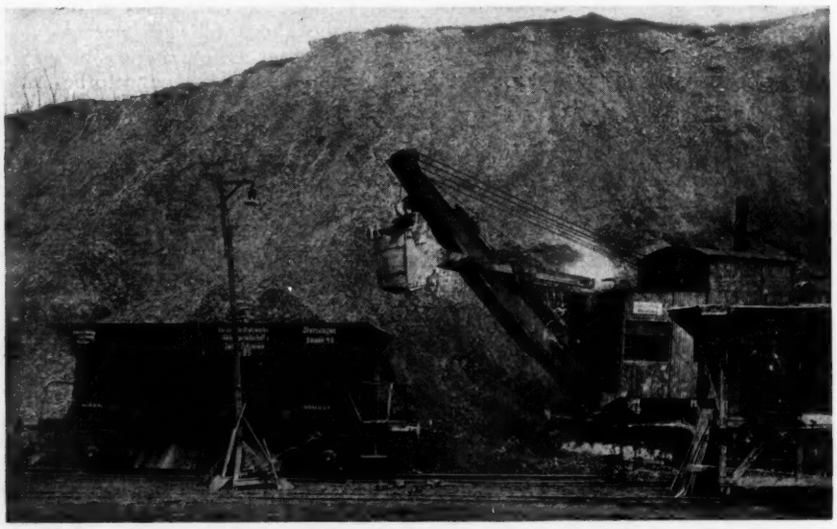


Fig. 3—A caterpillar-equipped shovel, with a 36-cu.ft. dipper, loading an 850-cu.ft. self-dumping steel railway car. To the right is a hopper employed in loading mine cars.

Because of the ability to concentrate power on shovel teeth, no difficulty is experienced in loosening and loading even the hardest of materials. Hard-burnt, sintered slag, for example, can be mined by an electric shovel with a dipper capacity of 36 cu.ft. at the rate of 900 mine cars, each having a capacity of 39 cu.ft., per eight hours.

Usually, however, the mine cars cannot be brought to the working site of the shovel, especially when the dump is too far from the pit. In such circumstances, a railway line must be laid to carry the filling to the mine. Loading the railway cars is done as shown in Fig. 3, but special provision must be made for transferring the filling from these cars to the smaller mine cars. If tipping or self-discharging cars are employed, they dump their contents into

pits or low-level bunkers at the destination, and a bucket elevator or inclined apron conveyor raises and delivers the material to an elevated storage bunker and discharging hopper, from which it is drawn off into small mine cars placed underneath. To grade the filling before it goes into the mine, the hopper is covered with a grid that retains the larger pieces. These are then sent to a second hopper.

A different type of plant for handling mine filling is shown in Figs. 1 and 2. The material is brought by rail, usually from considerable distances, to a point where a tipping device discharges the contents of the railway car into an elevated bunker, and from this bunker the filling is drawn off into small mine cars.

As indicated in Fig. 2, a shunting winch hauls the railway cars to the tipper, after the latter has first been lowered to the level of the track. When the hoisting ropes of the tipping platform are tightened, the car is locked automatically on the platform by crossbeams placed before the car at both ends. Not until this operation has been completed does the platform begin to ascend with the car. When the platform is above the particular one of the three bunkers into which the packing is to be placed, the tipping motor proceeds to tilt the platform along its longitudinal axis, whereupon the contents slide out from the under part of the car when the discharge opening is unlocked.

Inasmuch as the hoisting and tilting gears are independent of each other, the platform can be tilted while traveling up or down. Moreover, the tilting gear allows the tilting of either end. No matter how the cars with brakemen's cabin may arrive, there is no need to reverse them, and no turntable is necessary ahead of the tipper, because either end of the platform can be tilted. When the car is empty, the platform (and car) is brought to the track level again. Further slackening of the cables after the platform is at track level causes the lever, controlling the crossbeams that lock the car in position, to swing upward automatically. The car is then run off the platform to make room for the next one. This tipping plant is capable of unloading eight to ten 20-ton cars per hour.

A chain haulage system takes the empty mine cars up a slight gradient, from which they run down another gradient until they reach the bunker discharge openings, where they are stopped, filled, and then pushed off again, continuing their way down the gradient until they reach a point where they are hitched to the chain-haulage system, which takes them to the mine shaft. Mine cars intended to carry other materials than mine filling go past the bunker without stopping and run onto the sidings behind the bunker plant to be loaded.

Each of the three compartments of the bunker holds 5,650 cu.ft. of material. Their joint capacity thus suffices to make the loading of the mine cars fairly independent of the regularity with which the railway cars arrive. The bunker discharges are controlled entirely by hand.

■ ■ ■

Laboratory Feeder for Flotation Reagents

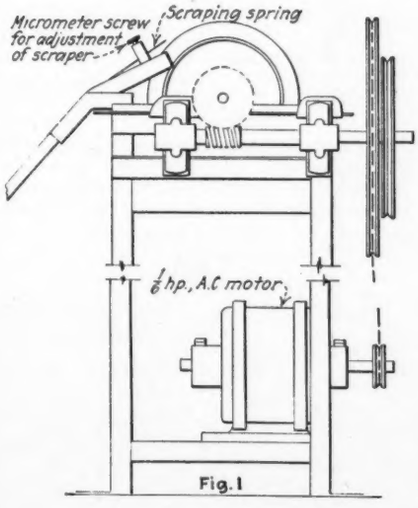


Fig. 1

CONTINUOUS tests on flotation, in order to be reliable, call for accurate control of oil and reagents. Feeders of the types used in plant operation are generally not adapted for tests on a small scale, where close regulation of minute quantities is essential. Easy cleaning of the containers is also an important feature in laboratory test, where a great variety of reagents often is tried out.

The apparatus shown in the accompanying cuts has been found to meet these requirements and has given satisfactory service in the Norwegian government's ore-dressing laboratory, according to its designer, Mr. Magne Mortenson, of Trondhjem, Norway. Addition of oil is made by an eccentric revolving disk, dipping into a storage tank. A scraper, made from a flat steel spring shown in Fig. 1, is held against the pheripheri of the disk. A wide variation in the amount of oil fed is accomplished by changing the pressure of the spring against the disk, which is done with a micrometer screw, and by using scrapers of different widths. Chemicals are fed with cups fastened along the edge of revolving disks placed on the same shaft as the oil feeder, and dipping into containers filled with the solutions to be tested, Fig. 2. These cups shown in Fig. 3 are made from short pieces of tubing, and the volume of a cup is regulated by varying the length to which the stopper, forming the bottom of the cup, is inserted. The amounts of reagent fed may be regulated by changing the volume of the cups and the number of cups used on each disk, and by varying the tipping angle when discharging the content of the cups.

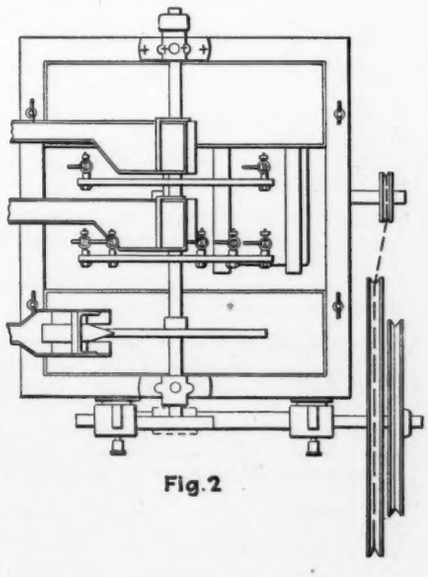


Fig. 2

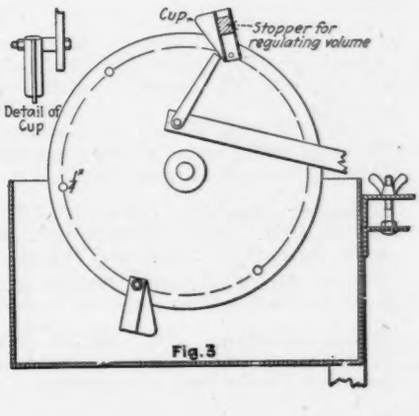


Fig. 3

PATENTS

Mine Skips. No. 1,795,215. March 3, 1931. I. F. Kent, Copper Cliff, Canada.
Design for a chair for mine skips.

Ball Mill. No. 1,793,495. Feb. 24, 1931. H. S. Lee and W. L. Kaiser.
Design for a screen for ball mills.

Miner's Pick. No. 1,791,688. Feb. 10, 1931. J. G. Sparks.
Design for a miner's pick.

Hoist. No. 1,791,894. Feb. 10, 1931. E. G. Gartin, assignor to Sullivan Machinery Company.
Design for a mine hoist.

Crusher. No. 1,791,584. Feb. 10, 1931. E. B. Symons, assignor to Nordberg Manufacturing Company.
Design for a cone crusher.

Percussive Tool. No. 1,792,893. Feb. 17, 1931. A. H. Collins, assignor to Chicago Pneumatic Tool Company.
Design for a portable percussive tool.

Dust Seal. No. 1,793,274. Feb. 17, 1931. B. G. Call, assignor to American Smelting & Refining.
A seal of calcine dust for feeding and discharging a conveyor.

Hoist. No. 1,791,742-45. Feb. 10, 1931. C. F. Osgood and R. C. Osgood, assignors to Sullivan Machinery Company.
Design for a mine hoist.

Electrical Prospecting. No. 1,791,933. Feb. 10, 1931. E. E. Mueser.
Method for electrical prospecting.

Metallurgical Furnace. No. 1,792,021. Feb. 10, 1931. F. H. Loftus.
Design for a metallurgical furnace equipped with regenerator for pre-heating the air.

Hoist. No. 1,792,092-94. Feb. 10, 1931. M. P. Holmes, assignor to Sullivan Machinery Company.
Design for a mine hoist.

Electric Precipitator. No. 1,793,664-65. Feb. 24, 1931. E. Anderson, assignor to International Precipitation Company.
Design for an electrical precipitator for removing suspended material from gases.

Precipitation of Sulphides. No. 1,793,-906. Feb. 24, 1931. N. C. Christensen.
Process of precipitation of metal sulphides from solutions by treatment with hydrogen sulphide in presence of calcium carbonate.

Grinding Mill. No. 1,794,041. Feb. 24, 1931. E. G. Stone, Wollongong, Australia.
Design for a ball or tube mill consisting of a frame with a series of cylinders rotatably mounted on this frame.

Charging Machine. No. 1,791,677. Feb. 10, 1931. H. R. MacMichael, assignor to American Smelting & Refining.
Design for a charging machine for Scotch hearths.

Beryllium Alloys. No. 1,790,155. Jan. 27, 1931. L. J. Keeler, assignor to Beryllium Corporation of America.
Production of beryllium alloys by adding the alloying metals directly to the bath, from which the beryllium is recovered by electrolysis.

Purifying Alloys. No. 1,790,164. Jan. 27, 1931. W. J. Merten, assignor to Westinghouse Electric Company.
Purification of alloys containing lead, tin, and copper by addition of calcium carbide to the molten alloy.

Mine Car. No. 1,790,326. Jan. 27, 1931. H. W. Sanford and W. O. McKamey.
Design for a mine car.

Electrolytic Zinc. No. 1,791,082. Feb. 3, 1931. G. Bianco, Turin, Italy.
An electrolytic zinc bath consisting of zinc amalgam, phosphoric acid combined with an alkali metal, sulphuric acid, aluminum hydroxide, and water.

Rare-Metal Recovery. No. 1,791,272. Feb. 3, 1931. C. V. Iredell, assignor to Westinghouse Lamp Company.
Process for decomposition of rare-metal silicates by heating the silicate with carbon at a temperature sufficiently high to convert the silicon and the rare metal into carbides.

Mine Tools. No. 1,791,382. Feb. 3, 1931. A. Schäfer, Handlova, Czechoslovakia.
Design for an anchored support for mine tools.

Hoist. No. 1,791,733. Feb. 10, 1931. L. A. Maxson, assignor to Sullivan Machinery Company.
Design for a mine hoist.

Purification of Zinc Chloride. No. 1,789,299. Jan. 20, 1931. J. O. Betterton, assignor to American Smelting & Refining.
Zinc chloride containing lead and salts of lead is treated with an excess of metallic zinc in a suitable container, where a slag of purified zinc chloride is formed.

Condenser. No. 1,790,012. Jan. 27, 1931. G. T. Mahler, E. C. Handwerk, E. H. Bunce, assignors to New Jersey Zinc Company.
Design for a vertical condenser for metallic fumes.

Tungsten Metallurgy. No. 1,790,088. Jan. 27, 1931. J. H. Brennan. Assignor to Electrometallurgical Company.
Process for removing arsenic from tungsten ore by treatment with sulphur.

Lead Refining. No. 1,794,647. March 3, 1931. J. B. Schuettenhelm, assignor to Bunker Hill & Sullivan Mining Company.
Process for recovering copper and arsenic from lead by introducing a charge of ammonium chloride into the molten lead.

Prospecting. No. 1,794,666. March 3, 1931. E. S. Bieler and H. G. I. Watson, Montreal, Canada.
Design for an apparatus for electric prospecting.

Percussive Tool. No. 1,792,888. Feb. 17, 1931. W. H. Benedict, assignor to Chicago Pneumatic Tool Company.
Design for a portable percussive tool.

Hoist. No. 1,792,114-16. Feb. 10, 1931. R. C. Osgood, assignor to Sullivan Machinery Company.
Design for a mine hoist.

Lead. No. 1,792,210. Feb. 10, 1931. J. O. Betterton, assignor to American Smelting & Refining.
Process for de-zinking lead by introduction of chlorine gas.

Hoist. No. 1,792,467. Feb. 10, 1931. C. F. Osgood, assignor to Sullivan Machinery Company.
Design for a mine hoist.

Roasting Furnace. No. 1,792,476. Feb. 17, 1931. H. S. Bailey and R. A. Bennett.
Design for a muffled-retort furnace.

Hoist. No. 1,792,109. Feb. 10, 1931. L. A. Maxson, assignor to Sullivan Machinery Company.
Design for a mine hoist.

Titanium. No. 1,795,361. March 10, 1931. O. T. Coffelt.
Process for recovery of titanium from iron ores by an acid leach and precipitation of titanium oxide from the leach solution.

Zinc Metallurgy. No. 1,795,412. March 10, 1931. R. H. Stevens, G. C. Norris, and W. N. Watson, assignors to Rhodesia Broken Hill Development.
Treatment of vanadium-bearing zinc ore for recovery of zinc and vanadium in two leaching steps by regulation of acid concentration.

Blasting Cap. No. 1,795,440. March 10, 1931. W. Pritchard, Jr., assignor to Hercules Powder Company.
Design for a blasting cap.

Sulphur. No. 1,795,705. March 10, 1931. R. C. Benner and A. P. Thompson.
Process for producing elemental sulphur consisting in a treatment of a mixture of a sulphide ore and a carbonaceous reducing agent in con-current flow with an oxidizing gas.

Drills

Rock Drill. No. 1,789,698. Jan. 20, 1931. J. C. Curtis, assignor to Ingersoll-Rand Company.
Design for valve.

Rock Drill. No. 1,789,859. Jan. 20, 1931. L. C. Bayles, assignor to Ingersoll-Rand Company.
Design for centralizer.

Rock Drill. No. 1,791,036. Feb. 3, 1931. T. L. Murphy, assignor to Ingersoll-Rand Company.
Design for valve chest.

Rock Drill. No. 1,791,061. Feb. 3, 1931. M. O. Knutson, assignor to Chicago Pneumatic Tool Company.
Design for spring handle.

Rock Drill. No. 1,791,974. Feb. 10, 1931. W. Prellwitz and R. H. Williams, assignors to Ingersoll-Rand Company.
Design for drill-feeding device.

Rock Drill. No. 1,793,619. Feb. 24, 1931. C. A. Hultquist, assignor to Independent Pneumatic Tool Company.
Design for drill-steel retaining device.

Digest of Current Technical Literature

Selected from abstracts of articles in the leading technical periodicals, prepared by Engineering Index Service, American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y.

Granite Quarries and Quarrying: Great Britain—"Mountsorrel Granite Quarries. *Quarry and Roadmaking*, Vol. 36, No. 408, Feb., 1931.

DESCRIPTION of equipment and operations of quarry at Welford House, Leicester, England.—E.I.S., New York.

•

Crushed-Stone Plants: Central United States—"Study of a Group of Crushing Plants in the Central West." E. C. Harsh. *Rock Products*, Vol. 34, No. 4, Feb. 14, 1931.

WASHING; primary crushing; hoisting on inclines; scalping; secondary crushing.—E.I.S., New York.

•

Metals Analysis—"The Microscope in Metallurgy." O. W. Ellis. *Can. Chem. and Met.*, Vol. 15, No. 1, Jan., 1931.

USE OF microscope in metallurgical practice for investigation of constitution of metals and alloys, for solution of problems of manufacture, and for control of production.—E.I.S., New York.

•

Copper Ore Treatment, Flotation: Spain—"A New Concentrator at Rio Tinto." R. O. Stokes. *Can. Min. Jl.*, Vol. 52, No. 4, Jan. 23, 1931.

NEW 2,000-ton flotation plant treats disseminated copper sulphides; novel arrangement of classifiers and ball mill; density recorders for flotation circuit; flow sheets.—E.I.S., New York.

•

Pumps, Centrifugal: Anti-Friction Bearings — "Anti-Friction Bearings for Centrifugal Pumps." E. L. Maag. *Power House*, Vol. 25, No. 1, Jan., 1931.

DESIGN and operating characteristics of anti-friction bearings; bearing lubrication; list of operating rules for average centrifugal pump running on anti-friction bearings.—E.I.S., New York.

•

Potash Mines and Mining—"Mechanization in German Potash Mining Industry." E. Sauerbrey. *V. D. I. Zeit.*, Vol. 75, No. 5, Jan. 31, 1931.

REVIEW of design and application of principal types of modern equipment including materials handling methods, layout of mines, conveyor systems, and locomotives.—E.I.S., New York.

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Grinding Mills—"A Survey of Modern Grinding Machinery." J. C. Farrant. *Chem Age*, Vol. 24, No. 604, Jan. 24, 1931.

DEVELOPMENT and fields of application of various classes of grinding machinery now on market.—E.I.S., New York.

•

Blast Furnaces: Smoke Density Measurement—"A Recording Dust Concentration Meter and Its Application to the Blast Furnace." A. W. Simon, L. C. Kron, C. H. Watson, and H. Raymond. *Rev. Sci. Instruments*, Vol. 2, No. 2, Feb., 1931.

THE ARTICLE points out that Ringelmann method of measuring smoke density, as well as so-called recording "smoke densimeters," does not measure true concentration of suspended material; amount of light transmitted is shown to be exponential function of concentration; recording instantaneous dust concentration meter making use of thermopile as light-sensitive element; charts obtained on blast-furnace gas are given.—E.I.S., New York.

•

Mining Camps: Plumbing—"Plumbing and Heating a Mine Camp in 'The Wilds' at 40 Degrees Below." T. N. Thomson. *Plumbers Trade Jl.*, Vol. 90, No. 2, Jan. 15, 1931.

ENGINEERING problems solved in Manitoba mining development with 6,000 ft. of piping and complete plumbing and heating equipment; plan of buildings at Flin Flon, Manitoba, with plumbing and heating lines.—E.I.S. New York.

•

Copper Refineries: Chile—"Project for Installing Copper Refinery in Chile." *Revista Financiera Salitre y Mines*, Vol. 5, No. 54, Nov., 1930.

ELECTROLYTIC refining process; power and fuel required; principal equipment items; factors of power plant installation; estimates of refining costs; desirability of interesting such organizations as Anaconda, Guggenheims, and Chilean Electric Corporation.—E.I.S. New York.

•

Mines and Mining: Diesel Engines—"Diesel Drive for Concentrator at Arizona Mine." *Power Plant Eng.*, Vol. 35, No. 3, Feb. 1, 1931.

REFINEMENTS of equipment including air and oil filters and lubricant reclaimers characterize Diesel plant which is simply housed because of geographical location; well water used for cooling pumped by air lift; packet water temperature raised 20 to 30 deg. F.—E.I.S., New York.

•

Mine Hoists: Electric — "Electrically Driven Winding Plants." *Engineer*, Vol. 151, No. 3918, Feb. 13, 1931.

TWO electric hoists for South African Gold Mines have been constructed at Openshaw Works by English Steel Corporation and Vickers Armstrong; one is of geared type and has bi-cylinder conical drum; 15 ft. diameter on outer barrels; second is of direct-coupled type driven by d.c. motor coupled to each end of drum shaft by flanges forged solid on shafts.—E.I.S., New York.

•

Lead Smelting—"Lead Smelting in Blast Furnace with High-Zinc Slags." K. Prior. *Metall und Erz*, Vol. 28, No. 2, Jan., 1931.

HIGH zinc content of charge is undesirable in lead-furnace practice; present views on constitution of lead-furnace slags in general and on combining forms of zinc contained in slags in particular; practical experiences on most suitable composition of high-zinc slags (metal content of slags, coke consumption, melting speed and related factors). Bibliography.—E.I.S., New York.

Pulverized Coal Drying—"Drying of Coal in Pulverizer." M. Weiss. *Montanistische Rundschau*, Vol. 23, No. 1, Jan. 1, 1931.

IN FORMS of mill used for pulverizing coal, temperature of mill, and consequently of coal, rises considerably; this evaporates some of moisture in coal, which is removed by air used for separating powder from still incompletely ground material; describes "suspension dryer" and several pulverizers in which this principle is employed.—E.I.S., New York.

•

Copper-Zinc Ore Treatment: Flotation—"Amulet Flotation Mill Practice." W. G. Hubler. *Can. Min. and Met. Bul.*, No. 226, Feb., 1931.

EQUIPMENT and practice at 300-ton preferential flotation plant of Amulet mine in Rouyn district of Quebec; main paper is discussion of solution in grinding circuits, in relation to production of soluble salts and their effect on flotation; analysis of ore treated; tests.—E.I.S., New York.

•

Limestone Mines and Mining—"Mining Limestone for Use in the Making of Beet Sugar." C. H. Vivian. *Compressed Air Mag.*, Vol. 36, No. 1, Jan., 1931.

MINE operated by Great Western Sugar Company, at Horse Creek, Wyo., producing about 10,000 tons per month.—E.I.S. New York.

•

Drilling, Diamond: Frozen Ground—Effects of Frozen Ground on Prospecting in Northern Canada." W. A. Johnston. *Can. Min. Jl.*, Vol. 52, No. 8, Feb. 20, 1931.

IN BORING to depth of 230 ft. near Churchill, on Hudson Bay, trouble was experienced in drilling because of freezing in of bits; data on depth of frozen ground at various localities in Canada and Siberia; use of brine is proposed to prevent diamond drills from freezing in holes; other difficulties due to frozen ground.—E.I.S., New York.

•

Ore Treatment: Flotation Reagents — "Flotation Reagents." B. W. Holman. *Instn. Min. and Met. Bul.*, Nos. 314 and 315, Nov. and Dec., 1930.

FUNCTIONS and classes of flotation reagents; modes of action; solubility and flotation; organic chemicals, tars, creosotes, and oils; reagents in practice; uses of acids, alkalis, metallic salts, benzene, and carbamide derivatives, fatty acids, oils, and distillation products. Bibliography.—E.I.S. New York.

•

Mines and Mining: Blasting — "Can Mine Blasting Damage Buildings?" L. Fiegler. *Zeit. des Oberschlesischen Berg. u. Hüttenmannischen Vereins*, Vol. 69, No. 9, Sept., 1930.

REPORT on observations of ground vibrations produced by mine blasting; vibrations were measured with Wiechert vertical seismograph; author concludes that ordinary mine blasting cannot damage buildings located in vicinity of mines.—E.I.S. New York.

Personal Notes . . . Comment . . . Criticism

J. H. A. Williams, president of Kildun Mining, left New York on March 17, for the property at San Luis Potosi, Mexico.

T. M. Broderick lectured recently at Princeton University on "The Geology of the Lake Superior Copper Deposits."

R. L. Botsford left England for Canada early in March, to join the staff of the Huronian Mining & Finance Company, Ltd., with headquarters in Toronto.

Robert Fennell, lawyer, of Toronto, was elected president of Barry-Hollinger Gold Mines at the recent annual meeting of the company. He succeeds **H. C. Crow,** who announced his resignation as a result of the press of personal business.

John D. Sullivan, associate metallurgist of the Southwest Experiment Station, U. S. Bureau of Mines, at the University of Arizona, has resigned and accepted a position as research metallurgist and chemist for the Battelle Memorial Institute at Columbus, Ohio.

Enoch Henderson, formerly connected with mining companies in the Michigan copper district, has been appointed superintendent of Noranda Mines, in Quebec. Mr. Henderson, a graduate of the Michigan College of Mining and Technology, went to Noranda three years ago.

Dale L. Pitt, general manager of Premier Gold Mines, was elected president of the British Columbia Mining Association, at the recent annual meeting in Victoria. **Charles Bocking,** and **T. W. Bingay,** respectively president of Granby, and vice-president of Consolidated Mining & Smelting, were elected vice-presidents of the association.

Thomas T. Merrifield, formerly chief chemist for Mond Nickel, at Coniston, Ont., and for several years chief chemist in the zinc plant of Consolidated Mining & Smelting, at Trail, B. C., has joined the organization of J. T. Donald & Company, at Montreal. He will be in charge of metallurgical, precious-metal assay, and referee work for this firm.

Creighton O. Waldorf announces the organization of Allied Engineers, Ltd., at 910 South Western Ave., Los Angeles, Calif. Associated with Mr. Waldorf as president are **T. Calvert Slater, G. Austin Schroter, M. A. Bard, A. B. Woodward, Jr.,** and **John Parris.** The organization has been formed to render consulting and financial services to the mineral industries.

Louis V. Bender, general superintendent of Anaconda Copper Mining's Reduction Works, at Anaconda, Mont., speaking at a recent monthly luncheon of superintendents of the Anaconda company, discussed the subject of operating costs at the smelter for January, using specially prepared charts, and comparing them with the average costs for the preceding six months. In the course of his discussion, Mr. Bender made the announcement that the January costs of the converter plant were the lowest in the history of the Anaconda company.

Dr. E. P. Partridge, of Ann Arbor Mich., and **H. W. Robbins,** of Chicago, have been appointed supervising engineer and editor, respectively, of the Non-Metallic Minerals Experiment Station of the U. S. Bureau of Mines, at New Brunswick, N. J. **Dr. H. H. Storch,** Dr. Partridge's predecessor, will take charge of the Physical Chemistry Section of the Pittsburgh, Pa., Experiment Station. Dr. Partridge comes to his new post from an associate editorship of *Industrial and Engineering Chemistry.* Mr. Robbins has been for the last fifteen years with the Illinois Steel Company, at Chicago.

JULIUS LOEB

Julius Loeb announced his retirement from the offices of treasurer and director of American Metal at the recent annual meeting of the company in New York. **Roy F. Wrigley** was elected to the board of directors to succeed him, and **W. H. Brady** was elected to the post of treasurer.

American Engineering Council, at its recent annual meeting, drafted a program to avoid business depression and unemployment, and adopted a report advocating the establishment of a competent agency to balance the forces of consumption, production, and distribution. Seven principal points of attack were recommended, as follows: "Maintaining or increasing the consumption of goods and services; balancing plant, machinery, and processes against production demands; controlling money and credit to satisfy the needs of government, business, and the individual; encouraging research activity to increase human well-being through development and progress in industry and business; and balancing public works against public needs."

Major J. Mackintosh Bell, geologist and mining engineer, in a recent address before the Ottawa branch of the League of Nations Society in Canada, said that "Canada, in the field of present increasing production and future prospects, is the land of promise to stem the tide of dwindling gold supply. Bearing in mind the wide distribution of the Keewatin rock with gold-bearing quartz veins within the Pre-Cambrian shield, one can scarcely believe that the rich deposits of Porcupine and Kirkland Lake are unique and that none other of equal merit will be found," Major Bell said. "Pessimistic depression concerning new gold discoveries in Canada is entirely unwarranted by the history of past results; actually in the investigation of the gold possibilities of Canada there exists a gold opportunity, for no other section of the earth's surface would appear more likely to provide discoveries of far-reaching importance."

The Joseph A. Holmes Safety Association, at its recent annual meeting in Washington, D. C., made awards for heroism in rescue work to the following men: Lee McKenzie, Oliver Iron Mining, Virginia, Minn.; Homer E. Power, Grasselli Mining, Waco, Mo.; and W. A. Stayton, Jr., and William Hawkins, both of Calumet & Arizona. William B. Hillhouse, Birmingham, Ala., was honored for his excellent safety record over a period of about five years as chief state mine inspector of Alabama. Dominick Kulaszewicz, with Pickands, Mather & Company, was honored for having worked at the Biwabik mine for 38 years without having a disabling accident. A certificate of honor was also given to Chris. Matson, mining captain of the Dunwoody mine for Pickands, Mather & Company, for having directed the sinking of seven mine shafts, over a period of several years, without the occurrence of a disability accident to any employee engaged in the work.

Use of Ore Guides

To the Editor of "E.&M.J.":

In connection with the subject of an article in a recent issue of *Engineering and Mining Journal* ["Use of Ore Guides," by Roland Blanchard, Feb. 23, 1931], on physical indications of value for tracing orebodies in veins and deposits, an instance of the peculiar value attached to the presence of a rare mineral may prove of interest.

For several years in the late 'eighties and 'nineties, in searching for a one-man mine proposition on my own account I conducted a number of prospecting ventures with machinery on abandoned mines and workings along the Mother Lode of California, from Plymouth south to Sonora, with little profit, however, though incidentally gaining intimate knowledge of the pecularities and mining lore of the old-timers, often of value, though lacking solid reason.

Roughly speaking, the Mother Lode is a wide series of veins lying on the western flank of the Sierran granodiorite formation, with the high-grade mines on the west limit, and the eastern belt of siliceous slates generally of too low a grade to be profitable, as is instanced in the Kennedy, on the west, now approaching 5,000 ft. deep, and the now abandoned Zeila on the eastern limit. The latter belt has received more attention, with greater expenditure and fewer returns, because it is difficult to find any exposed quartz that does not show gold enough to tempt the unwary, though rarely going more than $1.50 a ton.

The miners had evolved a theory that payable gold rock was associated with the presence of mariposite, a rare mineral whose bluish green plates made it very noticeable; but in its absence there was never pay-rock. We always bore this theory in mind, considering it to be a pretty sure guide to the persistence of gold, though not necessarily of its mining value, and the following anecdote will show how general was the belief.

The then famous mine owner, Col. Alvinza Hayward, had been brought into the Calaveras courts as defendant in a damage suit, which he defended on the ground of misrepresentation of values of a certain mine on the Mother Lode. He had undertaken to unwater the shaft situated between San Andreas and Angels, stipulating that if he threw up the bond and option, his pumps should remain the property of the mine, Without notice one Sunday, boiler and machinery were all moved off onto neutral ground, and the venture was abandoned. So suit was brought and the Colonel defended his action as having been advised by the spirits through a well-known lady medium, that the mine was valueless. His partner, Charles D. Lane, manager of the great Utica mine, then in bonanza, told me later that careful sampling down to within a few feet of the bottom had disclosed the absence of the prophetic mariposite, which was enough for the Colonel, whose foresight has certainly been vindicated by the mine's subsequent history.

In the same county, a few years previously, my heavy interest carrying a new 40-stamp mill and half a million investment had been abandoned following the decision of a most successful Cornish mine manager, who told me: "Young-fella-me-lad, God's clean gold can't live in the horse-dung stink of that mundic!" He knew, and he was right, though our Freiberger thought him a fool.

REGINALD W. PETRE.

Baltimore, Md.

R. L. Agassiz, president of the Copper and Brass Research Association, and of Calumet & Hecla Consolidated, in a letter to **Col. Arthur Woods,** chairman of the President's Emergency Committee for Employment, states that ". . . . The copper industry is doing everything possible to sustain employment. . . . . There has been some shortening of weekly working hours, but in all the mining communities the laboring men and their families are being taken care of. . . . . We are now working our mines four days a week. We have closed down certain of our activities, but the men employed there have been taken care of elsewhere. The factors which stand in the way of complete employment in the copper industry are the general depression of that industry and a large overproduction, which has resulted in the accumulation of unwieldy stocks of the metal."

Soviet Iron Industry

To the Editor of "E.&M.J.":

In the article on "Iron," in the issue of Feb. 9, Mr. Edwin C. Eckel states that "Today the Soviet output is greater than that of England and almost double that of Belgium; more than double that of Luxemburg. At the close of 1930 Soviet Russia ranked fourth, following United States, Germany, and France."

These statements are in error. The very figures in Mr. Eckel's article indicate that Soviet Russia is below Great Britain's production of iron and steel. Even accepting the Soviet government's statistics, and taking "estimated" figures instead of actual facts, pig-iron production in Russia hardly reached 5,000,000 tons in 1930. As the accounting year of the U.S.S.R. was changed in 1930 from Oct. 1 to Jan. 1, the above-mentioned production may relate to fifteen instead of twelve months. Assuming that 5,000,000 tons was the production of pig iron in Russia during 1930, this is considerably smaller than that of Great Britain, which in 1930 amounted to 6,200,000 tons. Steel works of Great Britain produced 7,300,000 tons for the same year. A comparison of one month's production taken at random is misleading.

The Russian iron industry in pre-Bolshevik days was controlled by private capital to the extent of 95 per cent, a half of which came from foreign countries—mostly France and Belgium. This industry was based on free competition, being regulated by the law of supply and demand of domestic markets, domestic production, and foreign importation. Average return on the capital invested amounted to about 4 to 5 per cent; and, for this reason, if not for any other, foreign capital was not easily obtainable.

The output of steel ingots and semi-finished products by the Russian industry in 1913 totaled 5,000,000 tons (300,200,000 poods). Pig iron was produced in the same year to the extent of 4,714,000 tons (282,960,000 poods). This production amounted to about 85 per cent of full capacity of blast furnaces and steel plants of Russia.

The Soviet government has only used the facilities of 1913 installations of former privately owned industry, and not to the full extent at that. Of the many projects for Russian iron-industry development, most are on paper. One or two extensive projects have been started with the assistance of American engineers, but a long time will elapse before the plants will be completely built, regularly operated and producing.

What will happen when these plants produce what they expect to produce is futile to predict. It seems to me, however, that the world iron industry has many more serious problems ahead than the threats of the Soviet government to conquer international iron markets.

FEODORE F. FOSS.

Wheeling, W. Va.

OBITUARY

Wilton E. Darrow, metallurgist, died on Feb. 18, at Stockton, Calif. He was 74 years of age. Mr. Darrow's work in the Mother Lode district of California included the formation of the Amador Metal Reduction Company.

Thomas H. Knotts, pioneer silver mine operator in Mexico, died in Des Moines, Iowa, early in March. He was 70 years of age. Mr. Knotts had control at one time of the Durango Mapimi mine, one of the largest silver producers in Mexico.

Joseph C. Stettheimer, a resident of Butte for more than 50 years, died at Oceanside, Calif., early in March. He was the owner of several mining claims near Walkerville, Mont., some property in the southwest portion of Butte, and formerly had a large interest in the Alice Silver Mining Company. Mr. Stettheimer was 80 years old.

Charles Rees, reverberatory foreman for American Smelting & Refining at Salt Lake City, died in a hospital in that city on March 10, following a major operation. He had been a resident of Salt Lake since 1913, at which time he joined the staff of A. S. & R. Mr. Rees was born in Wales in 1863, and was at one time superintendent of the Boston & Colorado Smelting Company, of Denver.

Howard Trumbo, president of the Cuban American Mining Company, and one of the best-known American residents of the island, died on March 16 in the Anglo-American Hospital in Havana. He was a former president of the American Club in Havana, and was a classmate of President Hoover at Stanford University. Mr. Trumbo was 56 years old, and had lived in Cuba for twenty years.

John G. Kirchen, of Tonopah, Nev., died on March 4, 1931, in San Francisco. He was 56 years of age. For 24 years he was general manager of the Tonopah Extension property at Tonopah, Nev. He was vice-president of the Nevada Mine Operators' Association, a member of the American Institute of Mining and Metallurgical engineers, and also of the Mining and Metallurgical Society of America. Recently he was interested with Thomas F. Cole in mining operations at Round Mountain, Nev. A native of Michigan, his was an active life in mining during the period of activity of Tonopah, Goldfield, and Manhattan, in Nevada.

Lloyd Tilghman Emory, a valued contributor to the pages of this publication in the past, died at the age of 49, in Barcelona, Spain, on Jan. 5, from cerebral abcess following a severe attack of influenza. He was born in Maryland, and graduated from the University of Pennsylvania in 1908. After practicing civil engineering for several years, he became interested in mining, making a special study of bauxite and aluminum. His articles in this publication dealt for the most part with the bauxite industry. Mr. Emory served as captain in the Ordnance Department during the War, and at its close engaged in consulting work, much of it abroad. For several years his headquarters were in Philadelphia, but from 1929 to the end, in London. At the time of his death he was connected with the American Cyanamid Company. He leaves a wife and child.

INDUSTRIAL PROGRESS

New Method of MINING OVERBURDEN in Germany

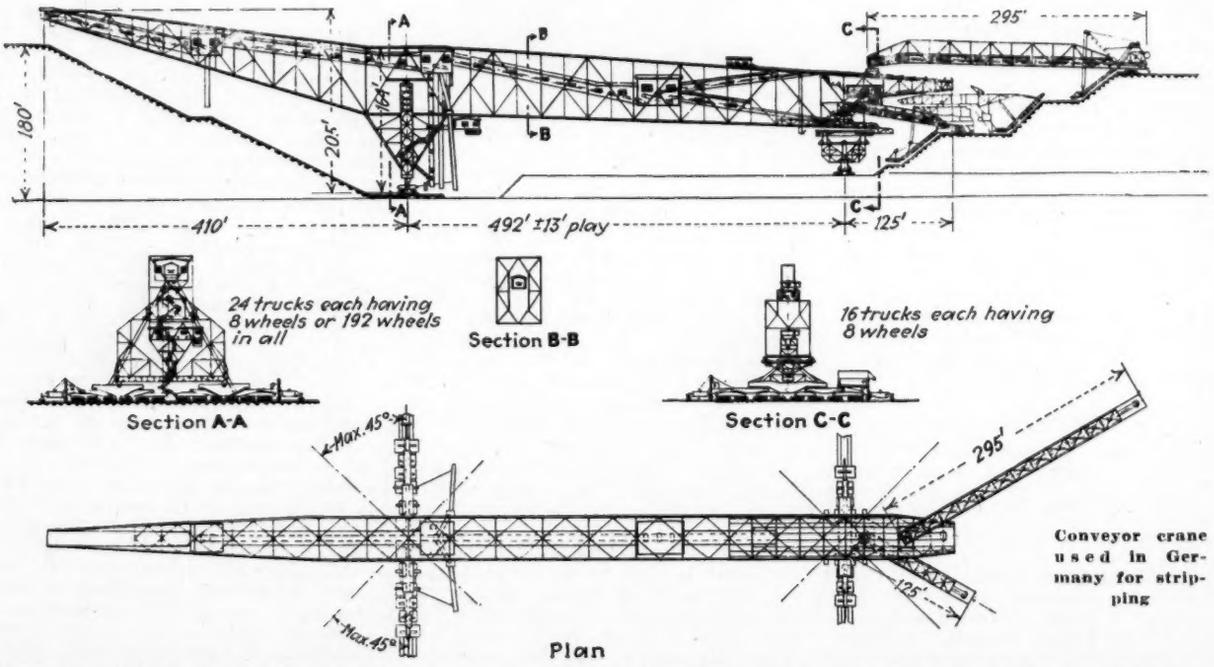
Richard Thomas
Chief Engineer, Lauchhammerwerk, Lauchhammer, Saxony

EXTENSIVE exploitation of the available lignite deposits and the resultant necessity for transporting enormous quantities of material have necessitated unusual accomplishments in the field of conveying within the past ten years. Whereas formerly the coal was mined only where there was a slight overburden, conditions now compel the exploitation of the less favorable strata in which the ratio of overburden to lignite is as high as 6 to 1. To uncover such strata for open mining has become possible, however, only through the newest technological developments in the construction of efficient and powerful equipment.

A great advance in the conveyance of overburden was the replacement of cars by conveyor belts. Whereas interruptions were inevitable in the former practice, belts afford an uninterrupted service which yields considerably improved results. In recognition of this fact, the large conveyor cranes were developed which are described in the following paragraphs.

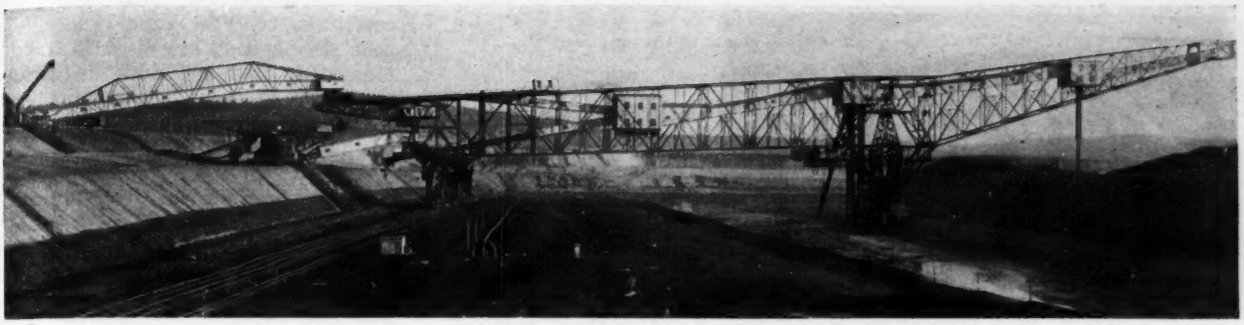
The capacity of conveyor cranes, which originally amounted to 654 to 916 cu.yd. (500 to 700 cu.m.), was increased with each newly installed crane, so that now an hourly capacity of 2,875 cu.yd. (2,200 cu.m.) has been attained. Concomitantly the dimensions of the cranes have grown; whereas the first crane had a working weight of 500 to 600 tons, conveyor cranes now run into 4,000 to 5,000 tons. These enormous weights, of course, represented an exacting requirement to the constructors, because the pressure on the terrain and the strain on the tracks could not be greatly increased. Again, the very large dimensions of the rolling cranes presented the difficult problem that they would have to conform to all the irregularities encountered in a trackage system.

An exemplary structure of this type, described in engineering circles as a marvel of design, is shown below—a crane recently erected by the Firma Mitteldeutsche Stalhwerke A. G. Lauchhammer, for the Braunkohlen und Brikett-Industrie A. G. in Mückenberg, Betrieb Friedländergrube. This crane has an output of 59,000 cu.yd. (45,000 cu.m.) of discharged dirt or soil in 21 hours and a total conveying length of over 1,300 ft. (400 m.). It rests on two "legs," of which the main one is on the discharge end on a bed in front of the refuse soil. The other leg is at the feeding end and rests on the uncovered or extruding coal. Both rolling legs are relatively long in construction,



Conveyor crane used in Germany for stripping

Total operating weight (no wind), metric tons.....4,850
Pressure on support, dumping end, metric tons.....2,785
Pressure on support, excavating end, metric tons.....2,065
Wheel pressure, dumping end, metric tons..... 14.5
Wheel pressure, excavating end, metric tons..... 16.1
Specific surface pressure, dumping end.....21.28 lb. per sq.in. (1.5 kg. per sq.cm.)
Specific surface pressure, excavating end.....27.66 lb. per sq.in. (1.95 kg. per sq.cm.)
Total power capacity of installation.....3,100 kw.
Yardage capacity, 21 hours.....42,510 cu.yd. solid material (32,500 cu.m.), or 58,860 cu.yd., loose material
Total distance of transportation from dredge in first cut to end of dump .....1,234 ft. (405 m.)
Total distance of transportation from dredge in cuts 2 and 3 to end of dump .....1,015 ft. (333 m.)
Speed of bridge.....26-39 ft. (8-12 m.) per min.
Travel of upper conveying bridge on main bridge..213 ft. (65 m.)
Travel of lower conveying bridge on main bridge..138 ft. (42 m.)
Daily advance of bridge with dredge.....7.54 ft. (2.3 m.)
Rubber belts used on conveyors:
8 belts, 55 in. (1,400 mm.) wide, total length..2,493 ft. (760 m.)
6 belts, 70.9 in (1,800 mm.) wide, total length..1,476 ft. (450 m.)
Speed of belts, per second.....6.5 to 11.5 ft. (2-3.5 m.)



The conveyor crane in service

to insure a uniform distribution of the enormous loads. The breadth of the structure at the discharge end is about 245 ft. (75 m.) and at the feeding end about 210 ft. (65 m.).

The enormous bridge rests as a joint in a swinging frame at the discharge end and at the excavating end is flexibly placed in a roller frame, which serves the function of permitting adjustments of the legs, and of the crane as a whole, to irregularities in trackage, surface and inclination. To this end it carries runners on the underside so that the lower supporting unit may have freedom in all directions; meanwhile its load always remains uniform. To allow for an inclined position of the bridge support in relation to its rolling member below (because of unfavorable terrain the allowance must be about 45 deg. in each direction), a bearing had to be built under the roll frame, consisting of a swinging frame. The various other frames on both ends of the crane are taken up by step bearings and the rolling trucks are mounted in a three-point system of bearings, so that all wheels will be uniformly loaded.

The conveyor belt, too, had to be built in unprecedented dimensions for the enormous load. Thus the main belts carrying the whole mass are 6 ft. (1.8 m.) broad, and the feeding belts, which carry the overburden from the individual dredges to the main belt, are 4.5 ft. (1.4 m.) broad. The speed of 9.75 ft. (3 m.) per second which was chosen did not prove to be detrimental to the endurance of the belts. Most of the belts are trough-shaped and run on triple rolls forming a trough. Only the connecting belts are flat so that they may absorb the high fall of the material to the main belt and give a mild transfer. At present the crane has to dispose of the total output of three dredges. Later it will serve four. To make this possible, two dredges feed to one transverse conveyor to a movable supplementary belt, which expedites the material to the main belt in the crane. The supports for the supplementary conveyors rest on special trucks at each end, one on the crane and the other on the dredge. The flexibility of these supplementary bridges allows a certain independence in motion of the dredges relative to the crane. Each bridge is designed for a possible diversion to each side of 25 deg. Inasmuch as the trucks on the crane are anchored obliquely, not horizontally, compensating weights are added in order to react against horizontal pressure on the trucks at the dredges.

Several difficult problems had also to be overcome in connection with the electrification of the crane. An alternating current of 5,000 volts comes in at the discharge end, and, though the main motors for the belt run on 5,000 volts, it must be transformed to 380 volts for the smaller and automotive motors. For the first time the use of alternating current motors in individual automotive units has been made possible without the application of the Ward Leonard control system.

In operation, a smooth start is obtained by the subdivision of motors into groups which are successively and automatically switched on, so that operation goes into full swing very gradually and the extreme speed is attained only after the last motors have been switched on. Conversely, the motors are switched off in the same manner, so that jerks are also avoided in coming to rest. The electric brakes act only after the crane has come to rest through the braking action of the motors.

In normal operation this switching system operates smoothly, but not when a break in the current occurs. In the latter case the braking magnet becomes active immediately and the resultant knock is avoided by a dampened action on the brake which affords several seconds and a gradual action in bringing the machinery to rest.

Of especial interest are the safety appliances which bring the crane to rest under any contingencies such as passage of the flexibility limit of the various apparatus, inclination and distortions of various sorts. When high wind pressures arise, an anemometer on the crane sets an acoustic and optical signal in motion and at 77-lb. (35-kg.) pressure the main switch is automatically opened. The whole electrical installation was furnished by the A.E.G. Although the constructional problems presented by this installation were difficult, they have been satisfactorily solved and the crane operates faultlessly.

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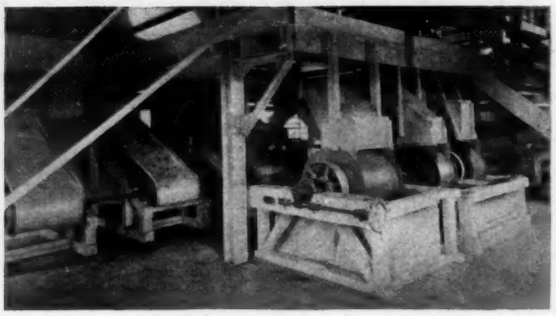
Many Difficult Separations Can be Effected by Magnetic Means

J. L. Hope
Dings Magnetic Separator Company
Milwaukee, Wis.

CONTRARY to the popular conception that only iron and steel are affected by magnetic force, some forty-odd other materials are susceptible in varying degrees. As a result, many industries are able to make profitable use of magnetic separation. Aside from such obvious use as removing tramp iron, this method has been found practical for treating complex mixtures, the components of which could otherwise be separated only by involved chemical means, or perhaps not at all.

Magnetic separation is used in concentrating manganese ores. Another instance, one involving high-intensity magnetic separation, is that of the purification of cryolite coming to the United States from Greenland and used as a flux for bauxite to produce aluminum. One of the complex separation problems solved by the Dings Magnetic Separator Company, Milwaukee, has been that of reclaiming stellite, an expensive steel alloy, for the Ford Motor Company. By accurate control of magnetic intensities this is being done successfully despite the fact that the stellite is intimately associated with iron and steel borings, which are also magnetic.

By far the most difficult of the various separation problems is that of removing very minute particles and impurities which are classified as feebly magnetic. This problem is encountered in separating fine flour of iron and iron oxide from feldspar, glass, sand, borax, and similar materials. By magnetic



View taken during construction of Richard mill show three Roche-type wet-belt machines and three B-N type dry magnetic drums

separation the operation is by no means as complicated as it may first appear. If the small particles are no more than feebly magnetic, it is possible to render them positively susceptible through the use of the double-drum-type separator.

This machine consists, in effect, of two ordinary drum-type separators, one above the other, so that the material, after passing over the first drum, is fed on to the drum below it. Through the phenomenon known as "magnetic reluctance," the first drum gives the material a magnetic charge, so that it can be separated on the lower drum. Thus, the passing of material such as oxidized native iron over one magnet prepares it for the second magnet by making it more susceptible.

The structure of the magnetic drums incorporated in this design involves stationary electromagnets with the pole pieces in a vertical plane. The revolving shell is made of either bronze or soft steel.

Another problem of separation that may seem difficult is offered by the mixture in which the elements are so intimately associated as to require intense agitation. This usually results when the material has been ground extremely fine. Here again magnetic separation offers an easy solution through another of its properties which is made use of in the agitating, drum-type separator. This separator will work with equal efficiency on either wet or dry material. Inside the revolving drum is a stationary magnet with its poles parallel to the axis but alternating in polarity. Thus material feeding over the face of the drum is intensively agitated as it passes through the quick changes of magnetic polarity. Such agitation is highly effective in dissociating one substance from another, because the magnetic portion is held firmly to the drum during agitation, whereas the non-magnetic portion is unaffected. A positive discharge is effected by an induced corrugated steel roller running in contact with the back part of the drum. This separator is well suited for concentrating magnetic iron ore which has been crushed to half-inch or finer.

By other arrangements of magnets efficient separation can be effected for almost all magnetic and feebly magnetic materials, even when they are combined with each other. The two types of separators mentioned represent only a small fraction of the special designs available for industrial use, and because of the large range of possible applications new designs are being worked out continually.

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The Equipment Review

Three new sizes have been added by Allis-Chalmers to its line of SSU single-shaft, two-bearing centrifugal pumping units, which now range from 30 to 500 g.p.m. at heads under 100 ft. Total inclosure of the motor housings on the pump end of these units and use of totally inclosed fan-cooled motors have recently been adopted. These pumps are intended for water supply, circulation in heating or cooling systems, air conditioning, and similar service.

New Developments in Ventilating Equipment

Recent developments in ventilating equipment for tunnel and mine work have been brought out by the Coppus Engineering Corporation. One of these is a motor-driven blower of the centrifugal type for 16- and 20-in. diameter ventilating pipe for pipe lines of considerable length. Installations have been made for lengths from 2,000 up to 4,000 ft. and with great success. The unit is known as the Ventair TM8 mine blower equipped with a 15-hp. motor, and is the latest of a group of centrifugal motor-driven blowers known as Ventair TM4, TM5, and TM6 with 1-, 2-, and 5-hp. motors respectively.

Another development is that of two additions to the company's compressed-air-driven blower line. These blowers are known as Ventair T6 and T8 and are the same except that T8 is for higher capacities than the T6. The two differ, however, to some extent from the smaller compressed-air-driven blowers of standard stock, known as T3, T4, and T5. In the latter, the turbine bucket ring is shrunk on the back of the aluminum fan; whereas in the new sizes a separate turbine is mounted on the blower base and the fan is mounted on the turbine shaft.

For handling volumes of air larger than can be handled with blowers of the centrifugal type, the Vano Type ST has been developed. This is also a compressed-air unit and finds its greatest use on 20- to 24-in.-diameter pipe lines.

For the Warehouse

A new bin section of heavy-gage metal has been developed for the stockroom by the Simplex Tool Company, Woonsocket, R. I. These sections can be built up like a sectional bookcase, each one nesting into the one below. They are made in four standard sizes. Widths of bins can be changed to suit individual needs. Each bin has a card holder for description of contents.

Manometer Easily Cleaned

A novel design of U-tube manometer and flow meter for measuring pressure or flow of any liquid, and of steam or gas, is now on the market. The distinctive feature is that the instrument can be removed from the line for cleaning, replacement, and inspection, without unscrewing the pipe connections. The manufacturer is the Meriam Company, Cleveland, Ohio. Patents have been applied for. The instrument consists of two separable parts—the head, which is permanently attached by the pipe connectors to the line; and the housing, which carries the scale and tube and which may be readily removed from the head by unscrewing a convenient wing nut. The instrument is designed to withstand all line pressures up to 100 lb. per square inch, and may be supplied to measure any differential pressures up to approximately 50 lb. per square inch—or flows giving an equivalent differential.

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Industrial Notes

General Electric Company, Schenectady, N. Y., has disposed of its trolley line material business to the Ohio Brass Company, Mansfield, Ohio. This includes overhead materials for electric railways, electrified mines, industrial haulage, and electrified steam roads. The transaction is said to be relatively of small importance, because of the volume of business involved, and, although of some advantage to both companies, it is principally of benefit to the users of this class of material.

Fuller Lehigh Company's general offices have been transferred from Fullerton, Pa., to 85 Liberty St., New York, effective Feb. 28.

Bucyrus-Erie Company has acquired control of the Monighan Manufacturing Corporation, Chicago, which will continue as a separate company, under the same management.

Rights to manufacture and sell the Stream Line filter in North America have been acquired by the Oliver United Filters, Inc.

NEWS OF THE INDUSTRY

Philippine Mines Increase Milling Capacities

Balatoc Mining and Itogon Mining, two of the three large gold producers in the Baguio district of the Philippine Islands, are increasing the capacities of their milling plants. Balatoc will raise the capacity of its mill from 175 to 350 short tons daily, and Itogon, which has been handling about 120 tons, will increase its mine output to 170 tons daily. Ore in the Baguio district is of fairly high grade, the average at the Balatoc mine being about $22 per ton. The Itogon grade is considerably lower.

At Balatoc, the increased capacity is expected to be available about July 1, according to J. E. Moore, mill superintendent. The total expenditure for new equipment will be about $125,000. Included will be a 7-in. Newhouse gyratory crusher, two Allis-Chalmers ball mills, two 4½x17-ft. Dorr drag classifiers, three 50x12-ft. Dorr thickeners, one 30x12-ft. steel Dorr thickener, a 14x18-ft. Oliver drum filter, and auxiliary equipment. Development results at the Balatoc mine recently have been favorable. Work has been centered on the 1,500 and 1,700 levels. In December a pocket of high-grade ore on the 1,200 level yielded 27 tons, from which an average of $1,000 a ton was recovered.

Itogon Mining had been handling only 60 tons daily early in 1930. Capacity was then stepped up to 120 tons, and additional equipment is now being installed to bring it up to 170 tons daily. Development is being pushed in not fewer than fifteen different headings, with the result that ore reserves have been increasd. On Dec. 31, 1930, 52,236 short tons of positive ore and 86,577 tons of probable ore were in sight, compared with 18,488 tons of positive and 28,075 tons of probable at the end of 1929. A total of 6,901 ft. of development was done in 1930. The company is employing 450 men.

Production of gold in the Philippine Islands in 1930 was estimated at 178,934 oz., compared with 139,740 oz. in 1929. The great majority of this came from the Baguio district.

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Delay in Bob Trial Explained

Delay in bringing C. V. Bob and his associates to trial before the Court of General Sessions of New York on four indictments accusing him of grand larceny has resulted from the federal investigation of Metal & Mining Shares and affiliated companies. The federal government may wish to bring suit against the companies, which were promoted by Bob, for using the mails with intent to defraud. The state indictments were returned four months ago, and Bob, his brother, and F. C. Russell are at liberty on bail. Stockholders in Metal & Mining Shares have recently received a letter asking for approval of a plan whereby Consolidated Chromium, a subsidiary with properties in Ontario, might lease its holdings. The letter was sent by C. C. Mollenhauer, of Brooklyn, receiver for Metal & Mining Shares.

Alaska Juneau Preparing to Mine North Orebody—Tonnage Up

For the last few years, development and production at the Alaska Juneau Gold property, near Juneau, Alaska, have been confined largely to the South orebody. A small tonnage of ore has been obtained from the North orebody, but it has been of low grade and confined to one or two stopes on the No. 4 level. As work in the South orebody is well in advance of production, however, part of the fixed crew has recently been transferred to the North orebody, for development work below the Gold Creek tunnel, or main haulage level.

The average gold assay value of all samples taken from the North orebody on the main haulage level, over an area 850x450 ft., is $2.01 a short ton, according to P. R. Bradley, consulting engineer of the company, in the annual report. In 1930, the average grade of ore mined was $1.10 per ton in gold. The North orebody is known to continue west for an additional 1,000 ft. to the 1545 crosscut. At that point it is 100 ft. wide and assayed $2.33 in gold per ton. This North orebody is progressively longer, with extra-lateral rights in depth. A winze has been sunk 410 ft. from the main haulage tunnel and development undertaken at 150 and 300 ft. The gold assay value of all samples from this winze and work done through the winze is $3.20 a ton. The station at 300 ft. below the haulage level will be the connection between the lower workings and a proposed new sea-level tunnel.

Raising and crosscutting on the adjoining Ebner Gold property, which Alaska Juneau operates under lease, failed to find additional ore above the main haulage level in 1930. Further work will be undertaken through the winze which is now being used for the North orebody.

Production at the Alaska Juneau property is being increased. In February, the average daily tonnage was 12,680 short tons, compared with an average of 11,460 in January, and of 10,811 throughout 1930. This is very close to the rated mill capacity of 13,000 tons daily and compares with the average of 11,790 tons daily maintained in 1930, the peak year in volume of tonnage mined. Recent changes in the mill have included installation of a new ball mill on the tube-mill floor and replacement of six cast-steel ball-mill shells. Milling costs in 1930 were 22.7c. per ton, compared with 23.2c. per ton in 1929. Mining costs were higher, however, at 28.7c. compared with 27.9c. in 1929. Total costs, including development, marketing, and general costs and interest, were 62.7c. per ton in 1930, and 61.6c. in 1929.

Alaska Juneau and Treadwell Yukon, both of which are controlled by the Bradley interests, of San Francisco, are jointly undertaking development of two groups of claims, covering 7,200 ft. of the outcrop of the Juneau gold belt, adjoining the Ebner group on the west. Ten-year options have been secured on these claims. If surface prospecting yields satisfactory results, underground development will be undertaken. If sufficient ore is developed, a bridge connection may be built across Gastineau channel to a Douglas Island mill site, somewhere on the property of Alaska Juneau.

■

St. Joseph Lead Suspends Work at Mine La Motte

The continued depression in the price of lead and the steady accumulation of supplies of the metal in the hands of the producers have caused St. Joseph Lead to close its Mine La Motte operations, in southeastern Missouri. Production was suspended during the week ended March 21. In recent months this unit has been producing concentrate with a lead content of about 550 to 600 short tons monthly. St. Joe made the first cut in production from its Missouri mines in November, 1930, after having operated at the normal rate for the first ten months of the year. Output was then cut to three-quarters of the normal of 15,000 to 16,000 tons of lead monthly.

Mine La Motte is equipped with a 1,000-ton mill and lies about 30 miles southeast of Bonne Terre—district headquarters of the company in Missouri. The nearest town is Fredericktown. St. Joe acquired the mine in 1925 and developed it through diamond drilling until 1927. Construction of the mill was then undertaken, and production started early in 1929. The unit is the smallest among the company's Missouri operations, contributing about 5 per cent of the normal tonnage. About 160 men are employed at the property, 90 comprising the underground force.

■

Sunshine Shaft at 1,700 Level

Sinking of the Sunshine Mining shaft has been suspended, as the present objective of 1,700 ft. has been reached at the property, in the Coeur d'Alene district of Idaho. Crosscutting will be started as soon as the waste and ore pockets have been completed. As the last level on which development was attempted was at 1,300 ft., the work on the new level, 400 ft. lower, will be followed with great interest. In addition to developing the Yankee Boy and Polaris veins, the crosscut is expected to encounter two other veins, through which the shaft passed in sinking. Production is being maintained at the normal rate, seven to eight carloads of high-grade silver concentrate being shipped monthly.

Consolidated M. & S. to Pay $350,000 for Fume Damages

Payment of $350,000 to the U. S. Treasury for distribution to American farmers suffering damages from its smelter fumes will be made by Consolidated Mining & Smelting, under the terms of the recommendation of the International Joint Commission which has been holding hearings for complaints in regard to the effects of the smoke on crops. The affected area is near Northport, Wash., across the boundary line from the Trail smelter of Consolidated M. & S. in British Columbia. The damage payment will cover all complaints up to Jan. 1, 1932. Complaints concerning damage after that date, if not adjusted by the company itself, will be adjusted within a reasonable time by the governments of Canada and the United States.

This case was referred in 1928 to the international commission, which had power to investigate the circumstances and make recommendations. Heretofore only waterway questions had been referred to the commission. The recommendation, which was unanimous, includes a method of disbursing among claimants the amount awarded.

The commission points out that the smelting company is erecting at a cost of $10,000,000 a plant which will use a large part of the sulphur in the fumes and thus remedy, at least partly, the deleterious effect that they now have. It recommends that scientists of both governments observe the plant and report from time to time any further additions that will help overcome the nuisance. The plant will consist of three sulphuric acid units, each with a capacity of 112 short tons daily. In addition it has a 35-ton pilot plant. All three units will probably be in operation by August, 1931, and are expected to use 123.6 tons of sulphur extracted from the fumes. This is about 35 per cent of the total sulphur content of the fume discharged from the smelter stacks.

■

May Abandon Railroad to Idaho Copper Property

Over the protest of the Idaho Copper Company, the Idaho Copper Corporation, and the Eastern Oregon Mining Association, Ralph R. Molster, examiner of the Interstate Commerce Commission, has recommended that Oregon-Washington Railroad & Navigation Company and the Oregon Short Line be permitted to abandon their Homestead branch, extending from Robinette to Homestead, about 24 miles, in Baker County, Ore. Mr. Molster suggested that provision should be made for sale within six months of the line to anybody desiring to purchase it at its fair salvage value for continued operation.

The railroads claim that traffic moving over the line was disappointing from the outset and that continued operation would involve waste of their funds, particularly since it would require reconstruction of the Oxbow tunnel, which caved in in April, 1930. Eventual mineral development and the time required for proving the mine served by the line cannot be forecast, said Mr. Molster. Granting the importance of the mining interests' commitments in the territory, they have not established, he said, that the burden of accumulating operating losses ought to be laid indefinitely upon the railroad.

The Plakalnitza copper mine, in Bulgaria, now part of Société Electro-Cuivre, mining subsidiary of Electrométallurgie de Dives

Annual Holmes Awards Made for Safety Performances

Outstanding instances of courage and resourcefulness exercised by miners and other mineral workers in the saving of life at personal risk and of exceptional safety achievements on the part of companies and organizations in the mining and allied industries were recognized by the Joseph A. Holmes Safety Association at its annual meeting held in Washington, D. C., on March 5. Awards of thirteen medals and certificates of honor were made to men engaged in coal mining, four to metal miners and one to a miner of non-metallic minerals. Certificates of honor were given to eight coal-mining companies, eight metal-mining companies, a group of 28 metal mines operated by one company, 6 cement plants, 4 rock quarries, two oil refineries, an organization of metal-mining companies, an organization of coal mining companies, a state mine inspector, and five other individuals.

The Tri-State Zinc and Lead Ore Producers Association, Picher, Okla., was cited for effective work in health and safety in the lead-zinc mines of the Tri-State region. Since 1925, fatalities have been greatly reduced. In addition to its excellent work in the prevention of accidents, this organization, in co-operation with the Metropolitan Life Insurance Company and the U. S. Bureau of Mines, has organized and operated one of the best health clinics for mining that has ever been known in the United States.

Metal-mining companies which received certificates of honor for outstanding accomplishments included Tennessee Copper, which operated 607,720 man-hours without accident; the Brule mine, of Berkshire Mining, at Stambaugh, Mich., which operated 1,044,768 man-hours without accident; the Gardner-Mackinaw mine, of Cleveland-Cliffs Iron, at Quinn, Mich., which operated 65,210 man-shifts with only one lost-time accident; the Montreal No. 4 mine of Montreal Mining, at Montreal, Wis., which operated 623,520 man-hours without accident; the Wauseca mine, at Iron River, Mich., which had only 9 lost-time accidents in three years; the Tilden open-pit mine, of Cleveland-Cliffs, at Ishpeming, Mich., which operated 13,091 man-shifts without accidents; the Wakefield mine, of Wakefield Iron, at Wakefield, Mich., for operating 538,049 man-hours underground and 1,012,296 man-hours in the open pit without accident; and the West Vulcan mine of Pickands, Mather & Company, at Vulcan, Mich., for operating 37,777 man-shifts without accident. Pickands, Mather & Company, operating 28 different mines in the Lake Superior iron districts, also gained special recognition for not having had an accident at any of its properties in November. The total man-shifts worked were 65,250.

■

Sullivan and Bunker Hill Ore Linked by New Deposit

Development work done during 1930 on the Flood-Pike-Stanley oreshoot, as the new find made in 1929 is now known, has shown that it extends from the Sullivan mine across into the Bunker Hill mine, according to Stanly Easton, vice-president and general manager of Bunker Hill & Sullivan Mining, operating in the Cœur d'Alene district of Idaho. The oreshoot occupies an area which has heretofore been unproductive, thus removing the distinction between the Sullivan mine and Bunker Hill mine orebodies. Total reserves of silver-lead ore were estimated at 2,481,858 short tons on Dec. 31, 1930, compared with 2,444,533 tons at the end of 1929.

The Flood-Pike-Stanley oreshoot has been extensively mined and further developed with gratifying results. It has been disclosed on the Pike, No. 9, and No. 10 levels, a total vertical distance of 700 ft. On the No. 11 level, work is now believed to be close to this ore. An additional level, 200 ft. below No. 19, has been opened in the Bunker Hill mine. The ore mined on No. 19 level was found on this new No. 20 level. Its full extent is not yet known, and development is being actively continued.

The Bunker Hill smelter and refinery handled the company's entire output for the first time in the last ten months of the year. Production consequently showed an increase over the record for the previous year. The company's mines produced 455,475 short tons of ore in 1930, compared with 451,111 tons in 1929. Concentrate produced totaled 88,467 tons, compared with 75,451 tons in 1929. The annual report shows a drop in the grade of lead from 55.7 to 49.3 per cent and of silver from 23.3 oz. to 20 oz. per ton; and the zinc grade increased from 5.15 per cent to 5.78 per cent.

Inco's Second Copper Cliff Mill Unit Ready on April 1—Ore Reserves Up

Construction of the second mill unit at the Copper Cliff plants of International Nickel, in the Sudbury district, Ontario, is practically completed. It will be ready for operation in April. It is a duplicate of the original 4,000-ton unit, which started work last August and which is now handling 3,500 short tons of copper-nickel ore daily, largely from the Frood mine. Completion of the concentrator leaves the transfer of the No. 1 separating unit (which separates copper and nickel contents of the smelter matte) from Port Colborne as the only important part of the Copper Cliff program which has not been finished.

International Nickel contemplates no other large capital expenditures during 1931, with the exception of the rehabilitation of the Mond, or No. 4, shaft at the Frood mine. This will eliminate the fire hazard and will facilitate handling Frood ore from below 2,800 ft., according to R. C. Stanley, president of the company. Standard Steel Construction Company, of Welland, Ont., will build the new steel headframe and hoist house. A 2,200-hp. Nordberg hoist has already been ordered.

The new equipment at the mines and metallurgical plants is giving satisfactory results, Mr. Stanley indicates. The new smelter has shown increased efficiency each successive month since operations started on July 1, 1930. The saving in fuel alone is sufficient to justify the change in smelting practice from blast to reverberatory furnaces. Current refining costs at the Ontario Refining plant, in which the company has a large interest, are low and the investment is apparently fully justified. Output is about 6,000 short tons of copper monthly at present.

Some changes have been made at the refining plants. A semi-finished material of high nickel content is now being produced at Port Colborne, Ont., which is shipped to Clydach, Wales, for refining there and replaces the bessemer matte formerly treated. By this means, copper is extracted and produced as electrolytic copper in Canada rather than as copper sulphate in Wales. The Acton refinery, at London, England, more than doubled its output of platinum metals during 1930—producing 71,260 oz., compared with 30,513 oz. in 1929. The plant now can handle as much as 300,000 oz. of these metals annually. The actual current percentage recovery of platinum metals is highly satisfactory and confirms estimates reported in the past as to the platinum-metals content of Frood ore.

Proved ore reserves as of Dec. 31, 1930, totaled 206,704,000 tons, compared with 202,620,000 tons at the close of 1929. Production in 1930 was 2,041,801 tons, of which nearly half came from the Frood mine. At the Frood mine, 2,416,000 tons was added to the reserves by development below the 2,000 level. It averaged 4.93 per cent copper and 3.53 per cent nickel, compared with the average grade of 3.61 per cent copper and 2.39 per cent nickel for the entire high-grade section of the Frood. Development work at the mine during 1930 totaled 50,803 ft., bringing the total for the last four years up to 21.8 miles. Frood can now furnish 5,000 tons of ore daily and mining efficiencies are increasing steadily.

Substantial additions to the Creighton ore reserves, totaling 2,648,000 tons, were made during the year by development between vertical depths of 2,400 and 3,400 ft. This is nearly half of the known reserves at the end of 1929. At the Lavack mine, work added 137,000 tons of new ore and at the Garson, 1,409,000 tons. Sufficient nickel was contained in the new ore developed in the mines in 1930 to supply market requirements for three years at the rate of 1929 consumption.

■

Interest Wanes in Gold Finds in Orange Free State, S. A.

Interest in the gold deposits of the Orange Free State, Union of South Africa, has waned among Witwatersrand mining men after the receipt of one or two discouraging reports. The deposits are near Rouxville and Zastron, in the southern part of the state. Rouxville is about 60 miles north of the Orange River and Zastron is 50 miles further to the northeast.

Gold is said to have been first discovered near Rouxville about five years ago, on the Draaibank farm, 18 miles to the east. During recent months, substantially higher assays, ranging from 12 dwt. to 1 oz. of gold per ton, have been obtained. The gold-bearing formation consists of shale, and the gold content appears to be very erratic and patchy. G. A. Chalkley, formerly engineer with the Consolidated Gold Fields group, was among the first visitors to the field. Several samples which he obtained yielded negative results, however, and he has advised his clients not to risk further expenditure on the options. Other option holders are reported to be continuing prospecting in the hope that some stretches of reef may prove more consistent.

At Zastron exploration has been conducted over a fairly wide area. On one farm, a drill hole has been put down to 180 ft. and is said to have yielded satisfactory results. Kotie Swanepoel is reported to have given an option on his farm, 5 miles from Zastron, for £50,000 to two Johannesburg men. Sir Thomas Cullinan, on the other hand, has not reported favorably, and further work appears to be necessary before any definite idea of the nature and value of the discoveries can be formed.

■

No Funds for Oregon Survey

The usual appropriation of $30,000 for a state mining and geological survey has been omitted by Governor Meier of Oregon from the state's budget. This board was created in 1929 and has been functioning for the last two years in cooperation with the U. S. Geological Survey. As the federal organization stipulates that it will match the state appropriation $1 for $1, work on a survey of Oregon's mineral resources will evidently be halted.

Noranda Increasing Reserves of Low-Grade Copper Ore

Like other large copper mines, Noranda Mines, operating at Rouyn, Que., is gradually becoming a low-grade large-scale operation. The ore reserve estimates at the end of 1930, contained in the recently issued annual report, show a total of 8,175,000 short tons of ore, compared with a total of 6,664,000 tons at the end of 1929. This increase was made despite extraction of the record total of 849,303 tons during the year. The grade of the reserves is definitely lower, and comprises a larger proportion of milling ore than in former years.

Although there was a small increase in the reserve tonnage of direct-smelting ore from 3,426,000 tons to 3,433,000, the drop in the grade from 7.53 per cent copper to 7.02 per cent more than offset it, so that the total copper contained is lower. The mill-grade reserves increased from 3,000,000 tons averaging 2 per cent copper and $3 gold per ton to 4,448,000 tons averaging 1.83 per cent copper and $3.52 gold. Reserves of siliceous ore increased from 238,000 tons averaging 1 per cent copper and $2.43 gold per ton to 294,000 tons averaging 0.8 per cent copper and $5.72 gold per ton. This improved grade resulted from the discovery of the new siliceous orebody known at No. 20.

The new concentrator addition, which was put into operation during 1930, showed an effective capacity of more than 700 tons daily, although rated at 500 tons. The old part of the mill, which has a 500-ton capacity, has been shut down because of the decrease in custom ore available for treatment. Installation of Cottrell equipment at the smelter to handle converter gases has not yet been completed, but otherwise the smelter additions are virtually complete. The plant handled a total of 733,971 tons of charge in 1930, an average of slightly more than 2,000 tons daily. An anode furnace has been built to prepare blister for shipment to the new Canadian Copper Refiners plant at Montreal East.

■

Little Change at Premier

Continued exploration underground, supplemented by 12,407 ft. of diamond drilling, failed to find any new orebodies at the Premier Gold property, near Stewart, B. C., according to the annual report for 1930. The main orebody was found to extend, at its eastern end, to the No. 6 level, where a small tonnage of ore was developed. Above the No. 5 level, particularly in the footwall, development was fairly successful in opening up various spurs and stringer veins, so that, despite extraction of 256,836 short tons of ore, the total reserves were only 49,831 tons less at the end of 1930 than at the beginning. They were put at 369,305 tons averaging 0.36 oz. in gold and 9.40 oz. in silver per ton on Dec. 31.

No attempt has been made to estimate the reserves at the Prosperity mine, in the same district, which Premier is also operating. The irregular character of the deposits makes such estimation difficult. Development at the property in 1930 totaled 7,112 ft., compared with 7,385 ft. at the Premier, although Prosperity produced only 18,049 tons of ore, averaging 80 oz. of silver to the ton.

Old Dominion Considering Shaft for New Orebody

A new shaft may be needed at the Old Dominion property, near Globe, Ariz., as the result of the development within the last two years of a new, low-grade copper orebody to the west of the present producing areas. Exploration has indicated what is probably a large body of low-grade concentrating ore on the Nos. 22, 24, and 26 levels. Work on the No. 26 level, which was driven west from the "A" shaft, has indicated a larger area and a better grade of ore at that depth than on the levels above. Because of the low price of copper and the desirability of reducing production, diamond drilling will be undertaken from the lower levels to determine the vertical limits of this new orebody, if possible, thus reducing expenses.

If drilling results should indicate that the orebody continues for 200 or 400 ft. additional in depth, a new shaft will probably be put down. The new orebody is about 3,000 ft. to the west of the "A" shaft, and it is felt that another opening would be more economical than to undertake development and exploitation from so distant a center. Estimated ore reserves on Dec. 31 were 1,720,070 short tons, averaging 2.1 per cent copper, compared with 1,275,460 short tons, averaging 2.4 per cent copper, at the end of 1929.

All the high-grade smelting ore has now been exhausted, the average grade of ore handled in 1930 having been 2.27 per cent copper, compared with 2.65 per cent in 1929. Despite the lower grade of ore, remarkable progress was made in raising the grade of concentrate produced in the company's flotation plant. The assay in 1930 averaged 26 per cent, compared with 19 per cent in 1929. Extraction was nevertheless maintained, being 89.3 per cent of total copper content, compared with 89.9 per cent in 1929. Mining and milling costs were both lowered.

■

Kildun Continues to Center Attention on Development

Although it has been making regular shipments of gold-silver ore, Kildun Mining is still centering its attention on development at the property near Matehuala, San Luis Potosi, Mexico, according to J. H. A. Williams, president of the company. No attempt will be made to put the mine on a regular production basis until sufficient ore has been proved to justify large-scale operations.

The Kildun property consists of 463 acres to the east of the Santa Maria de la Paz silver mine. To date, most of the development has been done on two veins, lying south of the main shaft and occurring within a short distance of each other. A third parallel vein has been cut, but further development has not been attempted. These veins are presumably extensions of those worked in Santa Maria ground and have an east-west strike, which veers slightly to the south at the east end. The shaft is now down to 1,475 ft. and crosscuts have been driven to the veins on the 500, 660, and 1,000 levels. Work on a crosscut at the 1,475 level is now under way. It is expected to cut the first vein within a few days. As the veins dip to the south, about 600 ft. of backs will be added by this work.

Drifting along the veins has shown that they form a junction about 1,000 ft. east of the Kildun-La Paz boundary line and also that they are converging at depth. The maximum length attained is about 1,400 ft. on the 660 level, with ore still in the face of the drift. On the 1,000 level a total of 1,200 ft. of ore has been proved on one vein. At this depth the ore is still oxide, but results at the La Paz property indicate that at the 1,475 level it will have turned to sulphide.

An interesting result of recent development has been the opening up of a gold oreshoot, which branches off to the northeast from the main vein system. It has now been proved for a distance of about 400 ft. and has a vertical range from 450 to 1,100 ft. A winze from the 1,000 level has been sunk on the main vein to the latter depth. Because of the low price of silver, all of the current shipments are being made from the gold vein. At present the ore goes to the San Luis Potosi smelter of American Smelting & Refining. When the sulphide ore has been sufficiently developed to permit shipment, however, consignments will probably be made to the nearer Matehuala smelter, thus effecting a considerable saving in freight rates.

Increased production will probably mean sinking of a new shaft. The present shaft has hoisted as much as 5,000 metric tons a month, using cages and in spite of the large amount of development work under way. With skips and a smaller development campaign, this figure could, of course, be greatly increased. A new shaft, however, would afford better ventilation and permit more economical development, in addition to furnishing additional hoisting capacity. Increased power requirements could be met by adding to the present Diesel engine plant, consisting of Ingersoll-Rand engines with a total capacity of 400 hp.

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New C. & A. Equipment Makes Expected Saving in Costs

Despite the failure to operate at or near capacity during 1930, as a result of the depressed copper price, Calumet & Arizona was able to realize the expected savings in costs through operation of its new mine and smelter equipment, states H. A. Clark, general manager, in the annual report. At the smelter at Douglas, Ariz., the three new 13x30-ft. horizontal converters exceeded the estimated savings anticipated when plans were first made for installing them in place of the six 12-ft. vertical units. Other new smelter additions included four ten-hearth Herreshoff roasters to supply SO_2 gas to the sulphuric acid plant. This permits using the 24 roasters in the original battery for metallurgical operations and gives the smelter a capacity of 100,000 tons of charge monthly. The second anode poling furnace has been installed, a new roaster stack built, and two cranes in the converter department remodeled.

At the Bisbee mines, the steam-driven high-pressure power plant has effected savings fully as large as anticipated. The new electric hoist being installed at the Junction mine is expected to make further savings. Although development was somewhat curtailed because of the depression, a "decided increase" was made in ore reserves. In the Campbell ore zone the continuity of the ore has been proved from the 1,500 to the 2,200 level. The shaft was deepened to 2,362 ft. and ore has been cut on the 2,300 level. In the Cole area, what appear to be the top of a large orebody was cut on the 1,400 level in the Atlas claim. Work is now suspended in this area, pending an improvement in the price of copper. The grade of ore extracted at the Bisbee mines in 1930 was 5.17 per cent copper, compared with 5.09 per cent in 1929.

At the Eighty-Five mines, Valedon, N. M., ore of sufficient quantity was developed on the 750, 900, 1,050, and 1,500 levels to show an increase in ore reserve over 1929, despite extraction of 80,561 short tons. The Emerald shaft is being deepened to 2,050 ft. after having been connected with the Jim Crow shaft, now down to 1,743 ft., on the 1,350 and 1,650 levels. Total development in 1930 was 9,335 ft., compared with 5,909 ft. in 1929. Grade of ore extracted was 2.74 per cent copper, compared with 2.87 per cent in 1929.

The mine and mill of the New Cornelia unit at Ajo, Ariz., now have a capacity of more than 20,000 short tons of ore daily, according to Gordon Campbell, president of the company. In 1930 the mill averaged only 6,508 tons daily. Stripping operations have been suspended at the open pit to keep expenditures as low as possible. Development during the year consisted largely of seven diamond-drill holes. Results are not given in the report. All the new grinding and flotation units in the mill have not yet been put into operation. In addition, a 400-ton test unit has been installed. Experiments are being conducted on the possibility of substituting balls for grinding in the Marcy mills, which now use rods.

■

Drop in Homestake Reserves Reflects Ellison Fire

Ore reserves in the Homestake Mining property at Lead, S. D., were 675,650 short tons of broken ore and 14,981,911 tons of blocked-out ore on Dec. 31, 1930, according to B. C. Yates, general manager. This compares with 686,495 tons of broken ore and 15,176,740 tons of blocked-out ore at the end of 1929, and shows a drop from a total of 15,863,235 tons to 15,657,561 tons, or 205,674 tons during the year. This decrease in reserves resulted largely from the curtailment of development work that followed the Ellison shaft fire in July, for the work carried on up to that month had yielded encouraging results in the lower levels. Even despite the decrease in total footage driven from 23,732 ft. in 1929 to 19,845 ft. in 1930, a total of 1,158,782 tons of new ore was developed. Had development work been maintained, the reserves probably would not have shown a shrinkage.

Because of the fact that the low-grade ore in the upper levels, where it can be mined very cheaply, has been exhausted, costs per ton of ore handled rose from $2.60 in 1929 to $3.28 in 1930. These costs include insurance, welfare work, and general expenses, but do not include outside exploration, taxes, or loss from the Ellison fire. The grade of ore handled in 1930 was $6.175 a ton, compared with $4.533 in 1929. Although the company does not publish figures for the grade of its reserves, it is generally supposed to be at least as high as the average in 1930.

J. O. Greenan Believes Life of Benguet Only Five Years

Ore reserves of Benguet Consolidated, operating a gold mine near Baguio, Philippine Islands, decreased from 379,164 tons at the end of 1929 to 342,350 tons at the end of 1930. This decrease is an indication that the mine is gradually being depleted. In the annual report, J. O. Greenan, mine superintendent, estimates the profitable life at about five years, with gradually decreasing production profits. Production in 1930 was the largest ever recorded, gross value of bullion being 3,546,952 Philippine pesos, or $1,773,476.

Work done on the 1,000 and 1,100 levels, the bottom levels of the mine, yielded negative results during 1930. At present a crosscut is being started from the station on the 800 level to cut the zone where diamond drilling yielded 11 ft. of high-grade ore. A check hole, recently drilled, showed but 7 ft. of ore averaging $3.30 a ton. No important orebody is anticipated in this area, because of the erratic character of the ore. On the 700 level, considerable development on the vein zone west of the shaft has indicated one short oreshoot. Most of the new ore developed during 1930 was found along the hanging wall of the vein system above the 400 level and in the 153 vein and 100 cross-vein west between the 400 and 500 levels. The total ore milled in 1930 was 114,786 short tons, averaging 30.90 Philippine pesos, or $15.45, a ton.

Development on the Hartwell group of ten patented claims in the Acupan district, near the Balatoc mine, has partly blocked out a promising oreshoot, according to J. W. Hausserman, vice-president of the company. About 1,300 short tons of ore averaging $60 a ton is indicated. The company plans mining and milling this ore within the near future. The option on the group will be exercised.

At the Baguio mine, in which Benguet has a considerable interest, ore reserves were increased in 1930. At the end of the year they were estimated at 340,526 short tons, with an average value of $19.97 a ton, which is an increase of 134,671 tons over the estimate at the end of 1929. In addition, the company has in its 313 and 237 veins, a considerable tonnage of ore averaging $10 a ton which has never been included in the estimates but which can probably be exploited at a profit. Details of the increase in milling capacity at this property may be found on p. 285 of the current issue.

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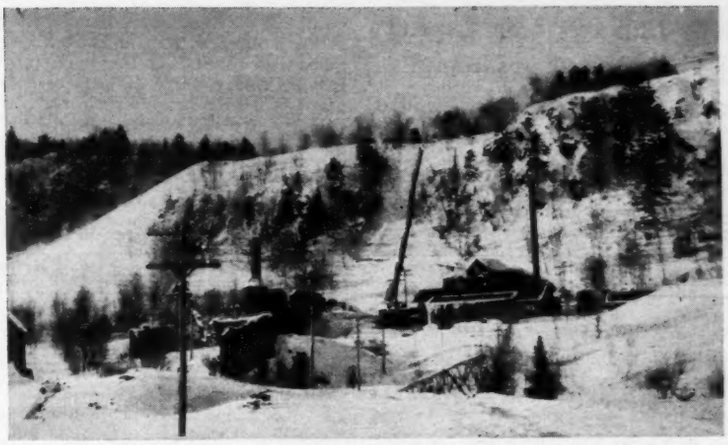
Barry-Hollinger to Continue Winze to 2,125 Level

Sinking of the three-compartment winze will be continued at the Barry-Hollinger gold mine, in the Boston Creek section of the Kirkland Lake District, Ontario. The winze has recently been completed to 1,875 ft., according to James Houston, superintendent, and crosscuts are being driven on the 1,750 and 1,875 levels. As soon as the No. 7 vein has been reached, sinking will be resumed and the next two levels—at 2,000 and 2,125 ft.—will be opened up.

Because of suspension of lateral development while depth development was undertaken, ore reserves above the 1,600 level decreased during 1930 from 18,000 to 10,000 short tons. During the year 31,725 tons was extracted. Reserves will be increased, the company expects, by the work at depth and production is consequently being continued at about 2,500 short tons monthly. The grade is considerably higher, however, being about $8.20 a ton, compared with an average of $6.87 in 1930 and $6.79 in 1929.



The Cliff mine, showing new power line and ruins of original surface equipment

■

Would Regulate Working Time in Michigan Mines

An eight-hour working day for mine, mill, or quarry employees is proposed in a bill introduced in the Michigan Legislature by Representative J. F. Jewell, of Hubbell, Houghton County, Mich. Employees who work more than eight hours would be entitled to overtime pay. Watchmen and emergency workers would be exempt from the eight-hour rule.

At present most of the copper mines in the Michigan district work on a two-shift basis. The workers are on shift for ten hours, with time for lunch.

■

Gold Hill May Raise Output

Installation of a sorting belt at the surface is expected to raise the grade of ore handled at the Gold Hill Development property, near Round Mountain, Nev. Up to the present, the mill has been handling ore as it comes from the mine, without any sorting. In addition to raising the grade, the company is making improvements underground which should permit handling a larger tonnage with the present hoisting equipment and, as a result, it may be able to operate the mill at the full capacity of 150 tons daily.

Underground, work is being resumed on the 400 level. A heavy water flow at that depth interrupted operations after 415 ft. of drifting had been completed. Now the shaft has been straightened, the pumps have been installed, and the hoist will operate from both the 225 and 400 levels.

■

A. S. & R. Enters Kingman Area

Development of the Moss mine, in the Silver Creek district, near Kingman, Ariz., is being undertaken by American Smelting & Refining. A contract for the work has been let to M. B. Lauzon, local mining man, and preparations are being made for moving machinery to the mine site. Within the last few weeks, high-grade gold ore has been discovered on the property by E. H. Dickie. It outcrops 200 ft. east of the original discovery on the property, from which about $500,000 was produced many years ago.

■

C. & H. Continues at Phoenix, Shuts Down at Cliff

Work now being conducted by Calumet & Hecla at the Phoenix property in Keweenaw County, Mich., will determine whether or not the Calumet amygdaloid opened in the Cliff property is of commercial value. If copper in paying quantities is found in the lode in Phoenix, work then will be resumed in the formation at the Cliff. This plan of action is considered to the best interests of Cliff stockholders, as it will conserve Cliff's remaining funds, amounting to $123,393. If the present work proves successful, it will provide a definite objective in Cliff and work can be resumed at a minimum expense.

Work was stopped in Cliff recently to conserve funds, pending developments in Phoenix. The Calumet amygdaloid is favorable in character where it was cut 520 ft. from the Cliff shaft, at a depth of 751 ft. below the No. 20 level. It is, however, only 6 ft. wide. Copper ore disappeared in a drift 40 ft. to the south, but in a drift of similar length to the north the mineralization continued. The lode would have to be wider and better mineralized to be of commercial value.

The work at Phoenix is being done at Calumet & Hecla expense.

■

Belmont Leasers Strike Ore

Leasers in the Belmont Copper property near Superior, Ariz., have cut a 5-ft. body of high-grade copper ore at a depth of 25 ft. below the 140 level. The ore has been exposed for a distance of 40 ft., and development is being continued to the east. Lead and silver are contained in the ore in substantial amounts.

■

New Vein at White Horse Mine

Development work on the 300 level of the White Horse property, in the Cerbat Mountains, near Kingman, Ariz., is reported to have cut a new silver-lead vein. It is about 700 ft. northwest of the main shaft. Several additional men have been employed, under the direction of A. Swan.

Survey Indicates Iron Deposit on Arizona Indian Ground

Deposits of iron ore have been reported to occur in the western part of the Fort Apache Indian Reservation, in Arizona. So that the best interests of the Indians might be considered in drawing up leases on such lands, an investigation of the deposits has been made by a geologist of the U. S. Geological Survey.

The bed of iron ore was examined in two localities on Canyon Creek, in the vicinity of Willow Creek and Chediski Mountain and in the vicinity of Bear Spring Canyon. The ore is hematite, ranging from soft, powdery bright-red material to hard, dense dark-blue iron oxide. More or less specularite is present. The most valuable deposits of iron ore in this region lie near the mouth of Bear Spring Canyon. Results of the brief surveys made indicate that here there is a bedded deposit of iron ore of good commercial grade and that the quantity of minable ore reasonably to be expected will reach 10,000,000 long tons. Prospecting by core drill will be necessary, however, to demonstrate this quantity with certainty. Possibly even more ore may be found.

These deposits are described in Bulletin 821-C of the Geological Survey, "Iron Ore on Canyon Creek, Fort Apache Indian Reservation, Arizona," which may be obtained from the Superintendent of Documents, Washington, for 15c. Included in this paper is a chapter by a mining engineer on the conditions affecting mining development of the deposits near Bear Spring Canyon.

■

Would Regulate Working Hours in California Smelters

A bill recently submitted to the State Legislature of California provides for regulation of the hours of labor in and about any smelter or refinery wherein silver, lead, gold or any ore is smelted or refined. In effect it provides that no person employed in or about a smelter or refinery shall be employed more than six hours a day, divided into two shifts of three hours each, with at least two hours intervening, and that no such person shall be employed for more than five days in one week. For non-compliance with the proposed enactment a fine of $500, imprisonment for not more than one year, or both fine and imprisonment, are provided.

The Selby lead smelter and refinery of American Smelting & Refining would be the chief plant affected by this regulation. Selby can handle 156,000 short tons of charge and produce 50,000 tons of refined lead annually.

■

Gold Metals to Deepen Shaft

Sinking of the main shaft of Gold Metals Mining, now down to 130 ft., will be continued to 500 ft., according to Homer Black, president of the company, operating at Manhattan, Nev. Development on the 70 and 130 levels has indicated a deposit of gold ore, from which several shipments of high-grade have been made. Because of the high cost of transportation, however, the company has suspended these shipments. It has acquired the old War Eagle amalgamation plant. If the necessary funds can be raised through sale of stock, the plant will be remodeled to use the cyanidation process and milling will be started.

■

Battelle Institute Will Study Properties of Lake Copper

The trustees of Battelle Memorial Institute, Columbus, Ohio, announce the establishment at the Institute of a research project, sponsored by Calumet & Hecla Consolidated Copper, of Calumet, Mich. The purpose of this project is to make a fundamental study of arsenical and argentiferous Lake copper in respect to its properties and application to industrial uses.

That copper containing small amounts of arsenic and silver has definite well-defined advantages has long been recognized, and recent developments have forcibly brought to mind the possibilities of further industrial applications. This research program is comprehensive in character and is in a most promising and fertile field.

G. L. Craig has been added to the Institute staff for work on this project, which is under the direct supervision of Dr. H. W. Russell and J. L. Gregg. Mr. Craig was formerly Research Fellow with the U. S. Bureau of Mines and more recently metallurgist for the Fairmount Aluminum Company.

■

Brookings Institution Lectures

A series of fifteen public lectures on the economics of mining are being given weekly from February to May by the Brookings Institution, at Washington, D. C. These lectures are delivered in the assembly room of the Carnegie Institution by a group of scholars and investigators in the economics of the mineral industries, including C. K. Leith, F. G. Tryon, H. Foster Bain, D. F. Hewett, C. E. Julihn, E. C. Eckel, J. W. Furness, T. T. Read, and G. S. Loughlin. The first lecture was held on Feb. 9. For further information, apply to the Institution, 26 Jackson Place, N. W., Washington, D. C.

■

Mining Fellowships Offered

The Michigan College of Mining and Technology, at Houghton, Mich., is offering twelve graduate fellowships for the academic year 1931-1932. They carry stipends of $1,200 annually and will involve research work on the copper and iron resources of northern Michigan. The work covers a full year, from Oct. 1, 1931, with one month for vacation. Further details may be obtained from the college.

The School of Mines, University of Alabama, near Tuscaloosa, Ala., is offering four fellowships in mining and metallurgical research for the nine months beginning Sept. 1, 1931. The salary is $675. Positions are open to holders of the degree of master of science, or its equivalent. Details may be obtained from J. R. Cudworth, acting director of the School of Mines, at University, Ala.

Brownell Outlines Plan for Silver Stabilization

An international agreement, formal or informal in nature, whereby nations that have silver for sale will commit themselves to a policy of not selling below a fixed price level, say, 35c. an ounce (the actual level to be selected at the proposed international conference, and perhaps changed from time to time as conditions alter), is all that is needed for stabilization of the price of the metal, F. H. Brownell, chairman of the board of directors of American Smelting & Refining, declared at the New York section meeting of the A.I.M.E. on March 12. Mr. Brownell emphasized the fact that such an agreement should be easy to reach, as India, which is the government with the largest amount of silver for sale, has shown its desire not to disturb the market unduly in the past. One of the largest gatherings of the season was present and apparently sympathized with the speaker's conclusions.

After tracing the history of silver and gold in the currency systems of the world, Mr. Brownell analyzed the present state of silver production and consumption. New mine production, he pointed out, is apparently not sufficient to meet the demands for subsidiary coinage, the arts, and the hoards of the Orient. The present depression in silver is the result, therefore, not of overproduction but of the threat that 400,000,000 oz. of silver, held by the Indian government, will be thrown on the market. Removal of that threat will encourage speculation in anticipation of renewed buying by Indian and Chinese peasants.

Mr. Brownell carefully distinguished between the Indian government and the Indian people. Although the former is liquidating its silver stocks and is going on a gold basis, the latter are still a large potential market for the metal. He said that the time is not yet ripe for new discussions of bimetallism, but that partial stabilization—no matter at what price—of silver is necessary to permit a large volume of trade with the Orient. His plan, he believes, furnishes the basis for such stabilization without the necessity of legislating. Several members took part in the discussion that followed, but no dissenting opinions were expressed.

The annual meeting of the section was held following the address. E. H. Robie read the treasurer's report for the year, which was unique among this year's financial reports in that it disclosed an increase in the surplus. R. M. Roosevelt, who has been chairman for the last two years, then introduced his successor, L. F. Strobel. Other members of the executive committee were presented.

■

Dayrock Sinks New Winze

A winze is being put down from the 100 level, east of the McPhillips fault, at the Dayrock Mining property, in the Coeur d'Alene district of Idaho. On the 200 level, exploration has failed to disclose the downward continuation of the narrow vein which has been developed in that section. Most of the company's production has come from the area west of the fault, which has been developed to the 300 level. Repairing and retimbering of the California Nos. 3 and 4 tunnels, on the company's California-Black Cloud holdings, is being continued.

BRIEF NOTES

Aldermac Mines. Construction of a 500-ton concentrator will be started at the property at Rouyn, Que., as soon as weather permits. About 3,000,000 short tons of ore, averaging 2 per cent copper and 60 to 70 per cent pyrite, is available at the mine, which has been idle recently because of the low price of copper. Sulphur will be recovered from the pyrite concentrate by means of the newly developed Freeman process. The company expects to obtain a large part of the market for sulphur in the Canadian paper field. In addition, copper concentrate will be shipped to the nearby Noranda smelter.

Bradshaw, Inc. Treatment of tailing from the Goldfield Consolidated dumps at Goldfield, Nev., has been resumed, after the usual winter suspension because of cold weather. Additions have been made to filter capacity, and the company hopes to be able to treat from 1,100 to 1,200 short tons of tailing daily, compared with last year's average of 1,000 tons. In 1930, Bradshaw was the fourth largest gold producer in Nevada.

California-Alder Gulch. The company has obtained deeds to 7,000 acres of placer and lode gold claims near Virginia City, Madison County, Mont. Development is being undertaken under the direction of Carl Zichosch. A high-grade gold vein, said to be 5 ft. wide, has been developed on the west flank of Alder Gulch. Shipments of high-grade ore will be made to the Helena smelter. Low-grade ore will be left for milling. The placer deposits may be mined by means of a drag-line excavator. Drilling near Virginia City has indicated the existence of a gold gravel deposit, capped by a lava flow, 60 to 300 ft. thick. Preparations are being made to sink a shaft through the capping for extraction of the underlying gravel deposit.

Chief Consolidated. To furnish a larger tonnage to the smelters, the company has suspended operation of its mill, in the Tintic district of Utah, and is shipping all production direct to smelters, in consideration of concessions in smelting rates, according to Cecil Fitch, general manager. The company has leased six different areas to other operators. Cost of development is not shared by the company unless ore is discovered, and then it gets a share of the profits that may accrue. As a result, gold ore has already been discovered on the Tintic Bullion, small amounts of lead ore have been developed in the East Tintic Consolidated, and lead-zinc ore has been discovered and developed in the Tintic Bullion. In addition, the company is operating five of its holdings itself.

Consolidated Metals. Additional equipment will be installed in the flotation plant of the company's Bishop Creek gold mine, near Bishop, Inyo County, Calif., to bring daily capacity up to 150 short tons before starting operations. Development work has indicated ore in one drift for a length of 170 ft., according to H. W. Klipstein, Jr., president of the company. It averages 10 ft. in width. At the company's Oceanic quicksilver mine, in San Luis Obispo County, Calif., sufficient ore for two years' operation at capacity is said to be in sight. Production in December was 105 flasks and in January 118 flasks. A regular output of 150 flasks monthly is planned.

Constitution Mining & Milling. In a letter to stockholders, J. P. Graves, president of the company, states that crosscutting of the lead-zinc orebody on the 800 level showed improvement, both as to width and grade, over the 400 and 600 levels of the mine, in the Coeur d'Alene district of Idaho. If the shoots of ore are as long as on the 400 and 600 levels, he anticipates a production of 100,000 short tons of ore from the area between the 600 and 800 levels. Construction of a fuming plant may be undertaken by the company "as soon as conditions warrant it." The mine is equipped with a 150-ton mill, but expansion of this capacity is expected. At present the mill is shut down pending improvement in metal prices.

Ely Gold Mines. About 100 tons of low-grade silver-gold ore is being shipped daily from the company's Revenue mine, in Robinson Canyon, Nevada, to the McGill smelter of Nevada Consolidated, where it is valuable for fluxing purposes. A new headframe, ore bin, and hoisting equipment have been installed. Production was started at 40 tons daily, but was increased to 100 tons on March 18.

Federal Mining & Smelting. No shaft sinking was done during 1930 at the Page-Blackhawk mine, in the Coeur d'Alene district. Stoping above the 1,200 level has proved the ore to be somewhat higher grade on the Tony vein at that depth than on the upper levels. Development east of the shaft on the 1,200 level in Blackhawk ground has failed to encounter ore. At the end of 1930, reserves were estimated at 431,500 short tons. Production during the year was 97,447 tons.

Glenallen Mining. The company can regain possession of a substantial part of its Park Galena property, in the East Park City district, Utah, if it will pay Park Galena Mining what has been invested in the property during the last five years. Park Galena Mining is now controlled by Charles Moore. This decision was recently handed down by the Supreme Court of the State of Utah, reversing a decision of the trial court. Estimates place the amount that will have to be paid to regain the property at between $250,000 and $300,000.

Gold Ridge Mine. Construction of a 300-ton mill on the Jones gold property, south of Jamestown, Tuolumne County, Calif., is under way. The company holds the property under lease and bond. A low-grade orebody will be worked by open-pit methods, using a power shovel.

Idaho Maryland Mines. Production of gold from the company's properties at Grass Valley, Calif., was $37,000 in January and $43,000 in February. Plans are being made to increase the monthly output to $50,000. Net profit at that rate of production is expected to be sufficient to retire the 221,454 shares of preferred stock outstanding. During 1930, the company is reported to have paid a $241,000 debt to the Harry Payne Whitney estate.

Kirkland Lake Gold. Ore has been developed by drifting on all levels between 3,700 and 4,300 ft., according to J. B. Tyrell, managing director of the company, operating at Kirkland Lake, Ont. A total of 4,149 ft. of drifting was done during 1930 at this depth, which is greater than the depth of any other Kirkland Lake mine, and as a result considerable high-grade ore has been developed. The recovery in 1930 was $10.245 in gold per ton of ore, compared with $6.60 in the previous year.

Macassa Mines. Shaft sinking to a depth of 2,000 or 2,500 ft. will be undertaken at the property, lying east of and adjoining Kirkland Lake Gold at Kirkland Lake, Ont. Macassa has been extensively diamond drilled and a limited amount of underground development has been done, but no ore has yet been obtained. Work will be directed chiefly to exploration of geological formations which carry ore in the producing properties to the west.

Moffatt-Hall Gold Mines. After having been closed for two years, the property at Kirkland Lake, Ont., will resume development early in the spring. Tenders have been invited for sinking a shaft to 200 ft., and plans include considerable lateral development and exploration at that horizon. Besides its Kirkland Lake property, Moffatt-Hall owns ground in Louvicourt and Bourlamacque townships, Que., where a program of surface prospecting will be carried out.

Mutual Mines. Construction of the company's new 100-ton flotation plant at its lead-silver mine, in the Coeur d'Alene district of Idaho, has been completed. The plant includes a 9x15-in. Blake crusher, 30x12-in. roll crusher, 6x4-ft. Hardinge ball mill, Dorr duplex classifier, ten-cell Fahrenwald flotation machine, and a three-leaf American filter. R. S. Handy, of Kellogg, designed the plant. It is at the tunnel portal and within a few hundred feet of the railroad. About 1,000 tons of ore are available on the dump for milling operations, pending completion of improvements underground which will facilitate mining. Production is expected to start toward the end of March.

Shattuck Denn Mining. Drilling is being continued on the high-grade copper orebody recently struck south of the shaft of the Denn mine, at Bisbee, Ariz. The first hole, put down from the 2,200 level at an angle of 57 deg. to the south, struck the ore at 160 ft. and continued in it to 320 ft., at which point the hole entered Calumet & Arizona ground. Development of this new orebody will be undertaken during the present period of depressed copper prices after further drilling to determine its extent has been completed. This will probably involve sinking of the shaft from its present bottom of 2,200 ft. to 2,500 or 2,600 ft., and undertaking lateral development at that depth. No definite decision on this matter has yet been made.

Silver Pick Consolidated. Two California gold properties have been acquired by the company. One is a group of eight claims in the Kennebec district, 6 miles north of Nevada City; the other is the property of the St. Louis Consolidated company, in the Willow Balley district, 2½ miles east of Nevada City. The latter property has been developed through a drift tunnel on the Jackson vein, now in 2,600 ft. The tunnel is reported to be in good condition, except for a short stretch near the portal, where it will have to be retimbered. Operations were started in 1890 at this mine. Very little work has yet been

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EXCLUSIVE

CABLES

FROM CORRESPONDENTS IN THE PRINCIPAL MINING CENTERS

Mount Isa Plans New Issue of 6 Per Cent Debentures

London, March 17.—Mount Isa Mines, Ltd., operating a lead-zinc property at Mount Isa, in northern Queensland, Australia, is proposing a new issue of debenture stock. At present the company's capitalization consists of 1,794,195 shares of £1 par stock issued, and £1,500,000 in convertible debenture notes, carrying 8 per cent interest. The new, or second, issue of debentures would be offered to present stock and debenture holders. It would consist of £666,667 in Australian currency, carrying 6 per cent interest. London subscriptions would be made at a fixed rate of exchange of £100 English sterling for £133.3 Australian currency. This issue will also be convertible into common stock, and an increase will therefore have to be made in the number of shares in the treasury, now 1,205,805 shares, of which 1,000,000 is available for conversion of the first debenture issue and the remainder is under option.

. . . . The additional funds are required to complete the plant (2,000-ton flotation mill and lead smelter) and to start production. American Smelting & Refining will subscribe 75 per cent and Leslie Urquhart, chairman of Mount Isa and Mining Trust, its controlling company, 25 per cent of any stock that is not applied for by other shareholders. Lead from the Mount Isa smelter will probably be shipped to the A. S. & R. refinery at Selby, Calif., for desilverizing until the company's plant on the Thames has been completed.

. . . . Another large debenture issue recently offered is a £2,000,000 block which Rio Tinto is putting out to permit its full participation in the financing of Rhokana Corporation, the Northern Rhodesian copper company. The Rio Tinto issue will be put out at 91½ and will carry 5 per cent interest. Part of the funds may be devoted to the possible erection of a copper refinery in England within a few years.

. . . . The report is being circulated here that Borax Consolidated is interested on a fifty-fifty basis with the Morgan interests, of New York, in a rich discovery of sylvite in New Mexico. Potash content is reported to be 28 per cent at a depth of 1,000 ft. or 50 per cent richer than the deposits now being exploited in Alsace and elsewhere. (Ed. Note—The U. S. Potash Company is the only known operating concern in the New Mexico field, where drilling has been carried on for several years by the U. S. Bureau of Mines. Nothing has been heard in New York of any connection between this company and the Morgan interests. U. S. Potash has sunk a shaft to 1,000 ft. near Carlsbad, N. M., and is said to be considering construction of a 2,000-ton plant.)

. . . . Rhodesia Broken Hill Development has suspended mining operations at its property in Northern Rhodesia. Zinc and vanadium production is being continued from the company's large dumps. In February the output was 1,233 long tons of electrolytic zinc and 15.25 long tons of 90 per cent vanadium pentoxide. About a year ago, the statement was made that the company's zinc production costs were £12 a long ton. The price of zinc has dropped to about that level within recent months.

. . . . To make possible more widespread speculation in tin metal by small traders, an organization of primary distributors has been formed to enable dealings in one-eighth of a long ton or multiples. A deposit certificate, guaranteed by Henry Bath & Son, will be issued against the purchase. Price will be regulated by quotations of the London Metal Exchange. A charge of 1.5d. annually will be made, per one-eighth ton, for storage and insurance until 1935. To encourage holding for a long term, the refund to the broker on sales for the first year will be £7 9s. 4d.; for the second year, £5 12s.; for the third year, £3 14s. 8d.; and for the fourth year, £1 17s. 4d. per ton.

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Rhodesian Congo Border Changes Name to Rhokana Corporation

London, March 16.—Rhodesian Congo Border Concession is no more. The company's name has been officially changed to Rhokana Corporation, Ltd., the meeting of stockholders on March 11 having adopted the directors' suggestion in this respect. The change was considered necessary because of the recent amalgamation, whereby the original Rhodesian Congo Border Company absorbed Bwana M'Kubwa and N'Changa Copper, both of which operated copper deposits in Northern Rhodesia where R.C.B.C.'s concession and properties were situated. The new name combines the old name and that of the important mine, N'Kana, which it acquired at the recent amalgamation. N'Kana will be the first of the company's large mines in operation, and, for the first few years at least, most of the output from the N'Changa and N'Changa Extension mines will be smelted at N'Kana.

. . . . Rhokana will not publish results of diamond drilling in the future. Only a few holes remain to be completed at the N'Changa and N'Changa Extension properties, and at N'Kana the drilling program has been abandoned, as sufficient ore has been proved to supply the mines for a long time. The company feels that nothing is to be gained by publishing further results, since its indicated reserves are already large (the copper content is generally estimated at more than 10,000,0000 short tons), and that to continue to do so would call unnecessary attention to what is now a minor phase of the operations.

. . . . Total cost of developing and equipping the N'Kana mine for production on a scale of 5,000 tons of ore daily is estimated at £4,775,000, of which £2,403,731 has already been expended. Carl Davis, technical director of Anglo American; G. W. Gray, director of Rio Tinto; J. G. Lawn, consulting engineer of Johannesburg Consolidated; and E. H. Clifford, of Mufulira Copper, have been appointed to the technical committee of Rhokana. Perhaps their chief problem will be the selection of a metallurgical process for the treatment of the mixed oxide-sulphide ore of the N'Changa and N'Changa Extension properties.

. . . . The Benguela extension of the Katanga railroad has now been completed, and for the first time the mines in the Belgian Congo and Northern Rhodesia are directly connected with the Atlantic Ocean. The line to Lobito Bay cuts off the long ocean haul, via the Indian Ocean, Suez Canal, and Mediterranean Sea, which was formerly necessary to put African copper on the European market.

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Brief Notes

(Continued from p. 291)

done on the property in the Kennebec district.

Sudbury Offsets. Drilling has indicated about 124,000 short tons of nickel-copper ore, averaging about 3½ per cent in both metals, at the company's properties near Sudbury, Ont. One orebody, containing 100,000 tons, is at Hollow Lake. The remainder of the tonnage is at the old Ross mine, about ½ mile west. Diamond drilling has totaled 15,000 ft. A program of underground development and further drilling from a depth of 150 ft. is recommended. The properties are along the strike of an "offset" from the north rim of the Sudbury Basin.

Tamarack & Custer Consolidated. Exploration has revealed a new orebody at the property in the Coeur d'Alene district of Idaho on the 1,200 (or No. 7 tunnel) and 1,350 levels. The new ore is in the Chesapeake vein and has been followed on the 1,350 level 150 ft. southeast to the Puritan fault and 140 ft. northwest to a point where it splits. The left split was followed an additional 280 ft. northwest and the right split was followed for 300 ft., all of which was well mineralized except for about 60 or 70 ft. Development and production have been largely suspended, but two leases are being operated on the upper levels.

Western New South Wales Electric Power. Construction of a Diesel-engine power plant at Broken Hill, N. S. W., Australia, by this company is now expected to be completed before the end of the year. The plant has been designed to meet the requirements of Broken Hill South, North Broken Hill, and Zinc Corporation both as regards electric power and compressed air. When completed, the present power plants of the mining companies will be closed. Power-transmission lines and compressed-air pipes have already been erected. The expenditure to date has been £420,000 and about £750,000 is expected to be the total cost.

MARKET AND FINANCIAL NEWS

Copper Outlook Improved, L. Vogelstein Finds

At the annual meeting of the American Metal Company, L. Vogelstein, chairman, outlined the company's holdings in African and other properties. He said that the company has substantial but not controlling interests in Roan Antelope and Rhodesian Selection Trust, and a smaller interest in Rhodesian Congo Border Concession. American Metal has a 42 per cent interest in Ontario Refining Company. This company, he added, began refining operations toward the end of 1930, and therefore there was no income from that source last year. The copper situation, in his opinion, has improved decidedly, owing to the production curtailment program now in force throughout the world.

World consumption of copper, according to Mr. Vogelstein, appears to be at present at the rate of 145,000 tons a month. World production is probably 10,000 tons a month less. The amount of copper above ground decreased about 42,000 tons since the end of last October.

Sales of copper, Mr. Vogelstein stated, were very satisfactory during February both in United States and Europe. He said that companies controlling 85 per cent of the world's production had sold approximately 130,000 tons of copper in February. He pointed out that an encouraging feature was that the amount of unrefined copper above ground was at present the lowest for the last eleven years. He said that the full effect of the curtailment would not make itself felt in refined output until March or April.

The indication is, he added, that the price of copper will improve slowly. He said that the market is still suffering from the accumulation of copper in producers' hands, and that he therefore did not look for any extravagant rise in price.

Mr. Vogelstein said that the Rhodesian mines could produce copper at a cost well below the present price. He pointed out that it had been estimated originally that these mines could produce copper at a cost of 8c. a pound when in full operation, and he said the indications still were that they could produce at that cost or even less. There was no desire on the part of Rhodesia to put more copper on the market than conditions would warrant, he pointed out. American Metal had a ten-year selling contract covering the output of Roan Antelope and Mufulira, and also a contract running several years covering sale of the output of the N'Kana and Bwana M'Kubwa mines, now owned by Rhodesian Congo Border Concession.

During the last eighteen months American Metal Company has been informally sounded by various parties as to the possibilities of a merger or consolidation. Nothing has developed from these proposals, and there are no negotiations pending, he said.

■

Hecla Mining 1930 Earnings

Although production was unchanged, low metal prices caused a drop in net profit of Hecla Mining from $1,879,478, after depreciation and taxes, in 1929, to $961,216 in 1930. Total value of silver-lead-zinc production in 1930 was $2,495,777, and operating income was $1,199,388. Comparable figures in 1929 were $3,563,305 and $2,227,465. Production in 1930 was 57,502,397 lb. of lead 1,560,323 oz. of silver, and 1,440,726 lb. of zinc.

The balance sheet of the company at Dec. 31, 1930, showed a total of $6,409,116 in assets, of which $1,545,801 was current assets. Current liabilities were put at $562,815 and earned surplus was $5,596,301. The company has investments of $3,375,771.

Homestake Mining Output and Profits Increase

Net income of Homestake Mining, after all charges, was $1,492,870 in 1930, compared with $1,044,070 in 1929. Operating profit, before reserve for depreciation and depletion, was $3,306,823, compared with $2,473,196. The increase in profit was not as large as in gold production. Total value of bullion output was $8,426,195 in 1930, compared with $6,517,838 in 1929. Costs rose as a result of mining higher grade ore at greater depth.

The balance sheet shows total assets of $17,368,706 and a debit, on the profit-and-loss account, of $831,797. This debit merely reflects the fact that the company has paid dividends from its depletion reserve, as the financial condition is sound. Bonds held have a total value of $4,205,903 and cash in bank totals $1,887,893. Bullion in transit on Dec. 31, 1930, was $348,862. At the close of 1929, the company's total assets were $17,848,107.

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TOM REED GOLD, operating a property in the Oatman district of Arizona, has resumed dividend payments by a declaration of 3c. a share, payable April 1 to stockholders of record March 16. The company has 2,000,000 shares of stock outstanding. Production in the last nine months of 1930 was $495,558 in gold-silver bullion, from which an operating profit of $188,429 was realized.

World Zinc Production in 1930

(American Bureau of Metal Statistics)

With zinc production for Belgium for 1930 available, the American Bureau of Metal Statistics has revised its estimate of world production for last year to 1,563,049 tons. The previous figure for 1930 was given as 1,561,704 tons. Revised totals, in short tons, follow:

	United States	Rest of World	Total	Daily Rate
January	52,010	91,086	143,096	4,616
February	44,628	85,289	129,917	4,640
March	48,119	93,627	141,746	4,572
April	44,435	89,655	134,090	4,470
May	44,556	90,131	134,687	4,345
June	43,458	85,821	129,279	4,309
July	40,023	87,164	127,187	4,103
August	41,012	86,548	127,560	4,115
September	40,470	83,532	124,002	4,133
October	40,922	87,264	128,186	4,135
November	32,097	87,238	119,335	3,978
December	32,682	91,282	123,964	3,999
Totals	504,412	1,058,637	1,563,049	4,282
Monthly average	42,034	88,220	130,254	....

Note: The production reported by Belgium, Germany, and Poland, included in the totals, is inclusive of the production of zinc dust. This refers to zinc dust that is put into marketable form for sale for consumption.

Copper Stocks Show Drop of 8,111 Tons in February

The February copper statistics for North and South America showed a reduction in combined stocks of blister and refined of 8,111 tons, against a decline of 11,510 tons in January. The reduction in stocks since last October amounted to 38,722 tons.

Shipments, domestic and export, totaled 100,051 tons during February, against 105,806 tons in the preceding month.

Production of refined copper in February was 99,853 tons, according to the American Bureau of Metal Statistics. The daily rate of production was higher than in January.

United States mine production in February was at the rate of 1,697 tons daily, against 1,550 tons in January.

Summary of Copper Statistics
In Tons of 2,000 Pounds

Production:	January	February
Mines, United States	48,059	47,504
Blister, North America (a)	66,770	68,786
Blister, South America (a)	24,064	24,124
Refined, No. & So. America	102,458	99,853
World, blister basis	129,390	128,685
Stocks (end of month):		
No. and So. America:		
Blister (b)	210,637	202,724
Refined	363,827	363,629
Totals	574,464	566,353
Great Britain (c)		
Refined	7,431	8,699
Other forms	1,747	1,784
Totals	9,178	10,486
Havre	3,920	3,785

(a) Includes direct-cathode copper. (b) Includes in process. (c) Official warehouses only.

U. S. Mine Production

	January	February
Porphyry mines	18,809	18,332
Lake mines	4,307	4,500
Vein mines	21,225	21,372
Custom ores	3,718	(a) 3,300
Total crude production	48,059	47,504
Daily rate	1,550	1,697

(a) Partly estimated.

Smelter Production

	January	February
United States	53,429	55,229
Canada	8,852	9,408
Mexico	4,489	4,149
Totals	66,770	68,786

Shipments
North and South America

	Export	Domestic	Total
1926	525,861	902,174	1,428,035
1927	641,865	824,844	1,466,709
1928	674,221	983,460	1,657,681
1929	586,594	1,119 409	1,706,003
1930			
January	30,358	69,932	100 290
February	29,597	61,879	91,476
March	30,523	73,644	104,167
April	29,196	50,017	79,213
May	49,115	75,760	124,875
June	44,818	71,887	116,705
July	42,466	75,436	117,902
August	38,319	56,810	95,129
September	37,873	65,169	103,042
October	38,246	75,703	113,949
November	45,051	62,693	107,744
December	39,169	69,854	109,023
Totals	454,731	808,784	1,263,515
1931			
January	45,597	60,209	105,806
February	39,415	60,636	100,051

World production of copper during February was at the rate of 4,596 tons daily, against 4,174 tons in January, and 4,395 tons in December. In January, 1930, the daily rate was 5,110 tons. Total output for February was 128,685 tons, against 129,390 tons in January. The statistics for the first two months of the current year, in short tons, according to the A.B.M.S., follow:

	January	February
United States	53,429	55,229
Mexico	4,489	4,149
Canada	8,852	9,408
Chile and Peru	24,064	24,124
Japan	7,003	7,190
Australia	300	1,218
Germany	5,353	5,067
Other Europe(a)	12,500	11,300
Elsewhere(b)	13,400	11,000
Totals	129,390	128,685

(a) Partly estimated. Includes production in countries other than Germany. (b) Chiefly Africa.

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Silver Gains in Favor as an Engineering Metal

The spectacular decline in the price of silver during the last two years is focussing attention to the possibility of extending the industrial uses of the metal. Recent important developments in the field of chemical engineering indicate a distinct trend in this direction, a trend so much more promising in view of the remarkable stride being made by this industry. This view is also shared by Donald MacDonald, who predicts an increasing industrial consumption of silver in a paper recently read before the Society of Chemical Industry. Already the employment of silver in the industrial plant is reaching appreciable dimensions, and pieces weighing up to 400 lb. have been installed. An important consideration in the use of silver is its high scrap value.

The interesting series of alloys, known as silver solders, are widely used both in ferrous and non-ferrous metallurgical industries. They consist essentially of the eutectic of the silver-copper series, with some zinc to decrease the melting point still further. In practice, a wide range of compositions is found, some as low as 10 per cent silver with as high as 30 to 40 per cent zinc. Their chief property is a low melting point, from 700 to 900 deg. C., in addition to malleability and ductility and high tensile strength. These alloys are therefore of great interest to the chemical engineer. They are soluble in nitric acid and in concentrated sulphuric acid, but the presence and proportion of zinc is an important factor in the resistance to other forms of corrosion, which usually is good.

Up to the present the chief industrial use of silver is in organic chemical engineering. Handling of acetic acid, which is particularly corrosive at the point of condensation, is the most extensive application. Use of silver is also spreading to allied trades, especially the food industries.

Note: The foregoing has been abstracted from an article on silver as an engineering metal, which appeared in the March 19, 1931, issue of *Metal and Mineral Markets.*

United States Lead Stocks Increase in February

With little change in the rate of consumption, lead stocks again increased during February. Stocks at the end of the month totaled 122,826 tons, against 113,145 tons a month previous, and 43,077 tons a year ago, according to the American Bureau of Metal Statistics.

Shipments reported for February totaled 34,439 tons, against 37,633 tons in January, and 64,249 tons in February last year. The daily rate of shipments for February, however, was actually somewhat higher than in the preceding month.

The daily rate of production showed little change for the month, amounting to 1,409 tons, against 1,400 tons in January. The daily rate of production for February last year was 1,933 tons.

Included in the February production of 39,464 tons of refined lead were 1,509 tons of antimonial. The stocks of antimonial lead at the end of the month stood at 8,802 tons, against 8,852 tons on the last day of January.

Lead production, stocks, and shipments, in tons, follow:

Production	Dec.	Jan.	Feb.
From domestic ore	48,517	43,405	39,464
Secondary and foreign	4,692	3,892	4,654
Totals	53,209	47,297	44,118
Stock at beginning (a)	90,402	103,247	113,145
Total supply	143,611	150,544	157,263
Stocks at end (a)	103,247	113,145	122,826
Shipments by difference	40,364	37,399	34,437
Shipments reported	40,595	37,633	34,439

(a) Domestic only.

The United States lead refinery statistics account for refineries at Omaha, Selby, Perth Amboy, Carteret Collinsville, East Chicago, Herculaneum, Grasselli, Federal, Kellogg, Galena, Newark, Matawan, Indianapolis, Joplin, and Ontario.

The industrial classification of domestic lead shipments, for December, January and February, according to the American Bureau of Metal Statistics, in tons, follows:

	Dec.	Jan.	Feb.
Cable	12,521	10,379	10,378
Ammunition	1,568	2,634	2,762
Tin foil	548	821	909
Batteries	3,574	4,877	1,504
Brass-making	177	329	118
Sundries	1,869	1,756	2,114
Jobbers	165	449	450
Unclassified (a)	20,173	16,388	16,204
Totals	40,595	37,633	34,439

(a) Of the shipments reported as unclassified, about one-third goes into white lead and about 30 per cent into red lead and litharge, as averages. Other important outlets in this classification are sheet and pipe, solder, and babbitt metal.

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United States Zinc Statistics

Domestic zinc statistics, in tons, for January and February, according to the American Zinc Institute, follow:

	Jan.	Feb.
Production	32,522	29,562
Production, daily average	1,049	1,056
Shipments	31,022	30,249
Stock, end of month	145,076	144,389
Retorts operating end of month	35,635	35,518
Retorts operating, aver. for month	35,137	36,823
Unfilled orders	30,251	33,453

Note: There were no exports of zinc during February.

Inco Earnings Halved as Sales Dropped in 1930

In 1930, International Nickel reports a net profit of $11,770,060, compared with $22,235,997 in 1929. Decreased sales of nickel and lower prices for copper were chiefly responsible. Operating profit, before deduction for depreciation, depletion, insurance, and interest on debentures, was $16,225,157 in 1930; $26,624,949 in 1929. As a result of the decline in income and the maintenance of the company's dividends, the earned surplus on Dec. 31, 1930, was $20,646,169, compared with $24,958,970.

Sales of nickel in all forms in 1930 were 75,284,352 lb., compared with 125,577,789 lb. in the previous year. World consumption apparently dropped from 136,000,000 lb. in 1929 to 88,000,000 lb. in 1930. Sales of copper, inclusive of copper in sulphate, increased from 81,833,776 lb. to 109,743,747 lb. Sales of products produced at the rolling mills (nickel content is included in figures for nickel sales) dropped from 41,094,851 lb. in 1929 to 26,454,916 lb. in 1930. Nickel output at Port Colborne was 61,704,271 lb. in 1930, 81,909,339 lb. in 1929; and at Clydach, 25,406,746 lb. in 1930, 27,987,869 in 1929. Platinum-metals output at Acton increased from 30,513 oz. in 1929 to 71,260 oz. in 1930, as a result of the larger ore tonnage from the Frood mine. Figures for copper, silver, and gold output are not given.

Total assets increased from $181,946,699 at the end of 1929 to $189,666,690, the balance sheet discloses. Increases were shown in the property account (from $136,298,358, after depletion and depreciation, at the end of 1929 to $145,481,480, end of 1930), in the investments ($6,939,327, 1930; $2,910,939, 1929), and in the stocks of metals on hand ($21,060,096, 1930; $17,109,312, 1929). Currents assets as a whole, however, were smaller as a result of a shrinkage in the cash position and accounts receivable. At the end of 1930, they totaled $37,245,883, compared with $42,738,003 in 1929. Current liabilities at the end of 1930 were $7,142,883; at the end of 1929, $10,506,164. Capital surplus on Dec. 31, 1930, was $60,132,646.

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U. S. Sulphur Production Increased During 1930

With a production of 2,558,981 long tons, sulphur output in the United States reached new high levels in 1930, according to the United States Bureau of Mines. This is an increase of 8 per cent over the output of 2,362,389 tons in 1929, the former record year. Shipments decreased, however, from 2,437,238 tons, valued at approximately $43,800,000, in 1929, to 1,989,917 tons, valued at $35,800,000, in 1930, or declines of 18 per cent in both quantity and value. The large decrease in shipments is due principally to a decrease in exports from 855,183 tons in 1929 to 593,312 tons in 1930, a drop of 31 per cent. Domestic shipments decreased from 1,582,000 tons in 1929 to 1,397,000 tons in 1930, or 12 per cent. The high rate of production in 1930, accompanied by declining domestic shipments and exports, resulted in an increase in producers' stocks from 1,928,000 tons on Jan. 1 to 2,497,000 tons at the end of December—a net gain of 569,000 tons.

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Financial Notes

PIONEER GOLD, operating a property in the Lilloet district of British Columbia, has declared an initial dividend of 3c. a share, payable on April 1 to stockholders of record March 16. The company has 1,657,750 shares of stock outstanding.

MODDERFONTEIN B GOLD, operating a property on the Witwatersrand, South Africa, reports a net profit of £481,058 in 1930, compared with £507,616 in 1929. Production was 840,000 short tons of ore from which 7 dwt. per ton was recovered. Operating profit was £543,437.

TEXAS GULF SULPHUR, operating in Texas, reports a gross income of $25,815,550 in 1930 and a profit of $13,972,085 after taxes. At the end of the year the company's surplus was $25,200,645, compared with $21,388,561 at the beginning. Total assets on Dec. 31 were put at $46,428,441, of which $7,518,800 was current assets.

DAYROCK MINING, operating a lead-silver mine in Idaho, reports an operating profit of $88,405 before depreciation, depletion, and taxes, in 1930. Production was $237,522. Operating profit in 1929 was $186,850. Output of ore in 1930 was 12,016 short tons, compared with 22,412 tons in 1929.

TAMARACK & CUSTER, operating a lead-silver mine in Idaho, reports an operating loss of $66,087 in 1930. Production was $129,280 from 20,334 short tons of ore. In 1929 the company recorded an operating loss of $6,450 on a production of $558,915.

VANADIUM CORPORATION will issue $5,000,000 in ten-year 5 per cent sinking fund debenture notes, to be convertible into capital stock. The proceeds for this issue will reimburse the company's treasury for expenditures on the ilmenite property in Virginia, operated by its subsidiary, Southern Mineral Products.

CONSOLIDATED METALS, operating quicksilver and gold properties in California, reports a net profit, after depreciation, of $121,300 in 1930. Production was valued at $233,198, other income bringing the gross up to $328,248. The company had total assets of $704,201 at the end of the year, current assets of $229,960, current liabilities of $84,255, and a surplus of $619,946.

C. & A. Earnings Shrank in 1930; Metal Stocks Down

Net profit of Calumet & Arizona, operating properties in Arizona and New Mexico, was $1,230,749 in 1930, compared with $7,733,603 in 1929—the result of smaller production and lower prices. A feature of particular significance in the annual report was the reduction in the company's stocks of metal (largely copper) from $6,324,308 at the beginning of the year to $1,975,148 at the end. Metals sales in 1930 totaled $17,160,634 and included 138,486,957 lb. of copper. Production was 88,839,719 lb. of copper, 1,476,092 oz. of silver, and 49,194 oz. of gold from its own and purchased ores. Comparative figures in 1929 were 130,486,607 lb. of copper, 2,002,956 oz. of silver, and 62,358 oz. of gold. The company's operating profit, before depreciation but after all tax charges, was $2,125,042, compared with $8,754,987.

The company's total assets, as shown in the balance sheet, were $84,378,760 on Dec. 31, 1930, as compared with $83,183,782 at the close of the previous year. The increase resulted largely from additions to equipment at the company's properties and from a substantial improvement in the cash position, which more than offset the decrease in metal stocks on hand. At the end of the year, the company had $4,380,919 in cash and $4,730,463 in notes and accounts receivable. Comparable figures at the end of 1929 were $650,520 and $786,157. As compared with total current assets of $12,021,369, the current liabilities on Dec. 31 were $4,874,748. The surplus was $62,500,771, compared with $62,955,736 at the end of 1929.

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Federal M. & S. in 1930

After deducting charges for taxes, general expense, and depreciation, the income of Federal Mining & Smelting in 1930 was $662,147, compared with $2,201,757. Gross value of production last year was $6,753,450, a considerable shrinkage from the 1929 total of $10,300,978. Operating profit was $1,130,361 in 1930, and $2,682,806 in 1929. Lead production in 1930 was 41,242 short tons, zinc production was 35,793 tons, and silver, 1,660,689 oz.

On Dec. 31, 1930, the balance sheet showed total assets of $15,734,449, of which $1,845,273 was current assets. Comparable figures at the end of 1929 were $17,039,325 and $2,831,401. The surplus at the end of the year was $7,136,691. As a result of the company's policy of retiring the preferred stock, only 29,867 shares were outstanding when the year ended, compared with 43,101 shares outstanding at the beginning.

Noranda Mines' Net Income Shows Moderate Decline

Net profit of Noranda Mines, after charges for taxes and depreciation, was $3,842,115 in 1930, compared with $4,287,173 in 1929. Operating profit was $6,133,834, compared with $6,708,-443 in the previous year, and the total value of metal production was $11,967,-472, compared with $10,947,290. Increased production was responsible for the relatively slight decline in profits, considering the drop in the price of copper. Copper production in 1930 was 76,142,246 lb., compared with 51,625,478 lb. in 1929.

The surplus on Dec. 31, 1930, was $3,890,115, compared with $3,967,600 at the beginning of the year. Total assets are put at $19,839,236 of which $2,778,-927 represents investments in other companies at cost. The larger part of this represents the holdings in Canadian Copper Refiners, Canada Wire & Cable, and Waite - Ackerman - Montgomery. Current assets total $6,134,082 and current liabilities $886,706.

■

Canadian Asbestos Production Shows Drop for 1930

Production of asbestos in the Province of Quebec, Canada, during 1930 amounted to 242,112 tons, valued at $8,390,163, according to a preliminary estimate by the Quebec Bureau of Mines. This is a decrease of 63,943 tons in quantity, and of $4,782,418 in value, contrasted with the totals for 1929. Canadian asbestos suffered because of the general business depression. Producers were hard hit by the keen competition resulting from the larger output of South Africa, and, more particularly, the freer offerings of the long fiber grades of Russian asbestos.

All of the Quebec asbestos mines have had to curtail their operations drastically, several properties closing down completely.

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Bunker Hill & Sullivan

In 1930, Bunker Hill & Sullivan realized a net income, after charges for depletion, depreciation, and taxes, of $1,529,338, compared with $2,329,046 in 1929. Gross operating profit from mining and smelting was $1,484,907 of a total production revenue of $5,953,808. Other income than that from mining and smelting was $1,032,359. Production from the Kellogg smelter was 84,-405 short tons of lead, 10,272,081 oz. of silver, and 46,500 oz. of gold.

At the end of 1930, the company's surplus was $11,085,923, compared with $11,108,321 at the beginning of the year. Current assets at the end of the year were $2,184,989, outside investments were $8,539,079, and miscellaneous mining stocks held were valued at $321,040. The company's total assets were put at $49,955,016. Current liabilities were $2,293,372 of which $1,104,737 was notes payable.

■

Expects Tin Agreement to Rehabilitate Industry

John Howeson, chairman of the London Tin Corporation, a $15,000,000 holding and operating concern, expressed confidence in the future of the tin industry at the annual meeting of the corporation held in London March 4.

"Compared even with the heavily restricted production of 1930, the initial quota output of the four countries will show reduction of more than 20,000 tons," Mr. Howeson pointed out, "and though it is hard to believe that consumption will not gradually regain at least some of the ground lost last year, it is quite impossible to believe that there can be any further substantial relapse.

"The pivotal feature of the scheme, however, is its elasticity, which is indispensable to the maintenance of equilibrium between supply and demand. If the initial quotas of production allocated prove excessive, the scheme provides for early and, if need be, drastic rectification. However, the contrary seems much more likely. The last two months have shown outstanding accession of activity among tin-plate manufacturers in United States; also signs of recovery in the automobile industry."

Dealing with the question of accumulated stocks, Mr. Howeson declared the excessive stocks had been responsible for the subversive market in the metal. It was clear this accumulation of unwanted stocks could not be made to disappear into consumption by a stroke of the pen, he said. It is vital to the industry and to the successful operation of the scheme that excess stocks should pass as rapidly as possible into hands strong enough to resist temptation to throw them prematurely into a market unready to absorb them.

Mr. Howeson revealed he had discussed curtailment and tin prices with some of the principal consumers and metal interests in the United States. He had no hesitation in saying they were altogether opposed to uneconomic prices. "They prefer, and say so categorically, that producers should make a reasonable profit, so that there may be an adequate inducement to provide for the increasing needs of the future. It is a fundamental error, also, to suppose there is opposition on the part of our friends and best customers across the Atlantic to regulate output aiming at a fair equilibrium between supply and demand. But they do take exception to violent oscillations in price which have so constantly disturbed all their arrangements in the past, and in so doing have recklessly stimulated search for substitutes."

Premier Gold Profit in 1930

Despite inclusion, for the first time, of profits from the Prosperity mine, the drop in the price of silver cut net earnings of Premier Gold in 1930. After all charges, the British Columbia enterprise reported a net of $388,071 in that year, compared with $459,575 in 1929. Gross value of production from both Premier and Prosperity mines was $2,396,946 in 1930, from which an operating profit of $1,273,555 was derived. At the close of 1930, the company reported total assets of $4,869,295, of which $2,203,292 was current assets. At the end of 1929, assets were $6,100,-860. Production from the Premier mine was 2,760,787 oz. of silver and 90,084 oz. of gold; from the Prosperity mine, 1,436,557 oz. of silver and 384 oz. of gold.

■

Old Dominion Loss High

Increased exploration and development, coupled with low price of copper, resulted in a net loss, after depreciation charges, of $887,824 for Old Dominion in 1930. The company's income from sales of metal was $3,106,933, representing 27,258,159 lb. of copper and some silver and gold. Actual production was 17,596,795 lb., the excess amount representing stocks on hand at the beginning of the year. Production in 1929 was 18,943,441 lb. Total assets on Dec. 31, 1930, were estimated at $19,354,009. Of this amount, only $1,466,855 was current assets. Current liabilities were $354,452. At the end of the year, after deduction of depletion, the company's surplus was $29,573, compared with $1,250,219 at the beginning.

■

Park Utah Consolidated

In 1930, Park Utah Consolidated recorded a net loss, after all charges except depletion, of $142,285, compared with a net profit of $467,722 in 1929. Low metal prices reduced the gross revenue from production to $1,426,563, compared with $2,808,089 in 1929. Operating loss was $37,162. Production was 34,073,606 lb. of zinc, 28,040,599 lb. of lead, 1,598,983 oz. of silver, and 17,679 oz. of gold. On Dec. 31, 1930, the balance sheet showed total assets of $7,590,575 and a surplus of $5,385,208. Current assets were $1,762,443, of which $1,513,027 was in government securities. Current liabilities were $101,867.

■

LONDON TIN, operating properties in Nigeria, reports an operating profit of £309,411 in the year ended Sept. 30, 1930, and a net profit of £274,290. In 1929, net profit was £137,-035. The company has interests in 64 different tin-mining companies, in addition to its own mines, which, in 1930, produced 2,401 long tons of concentrate.

Copper Reduced to 10c. in Quiet Market—Silver Above 30c.—Lead Dull

New York, March 19, 1931.—A period of unsettlement in Wall Street checked some of the improvement in sentiment in metal circles, and trading declined to a very low point in the last two weeks, at least so far as the major items were concerned. Copper prices receded to the 10c. Connecticut basis. Lead was reduced in price to the extent of 10 points, owing to dull business and the steady accumulation in supplies. Zinc held at around 4c., with no selling pressure in evidence. Tin was steady on support from the London group. The one bright spot in the market, however, was silver, which advanced sharply on covering by bear operators. The demand for quicksilver improved and higher prices were realized. Antimony also sold at higher levels.

Copper Quiet

Attempts to raise the price of copper on the belief that business has improved sufficiently to warrant a higher market met with no success, owing largely to a temporary reversal in sentiment in financial circles. The business world is looking to Wall Street for signs of a turn in the trade situation, with European observers particularly keen in following events in that quarter. The active foreign demand of February last was largely responsible for the firmer tone which prevailed toward the close of the second month. Early in the period under review some business was placed at 10½c., delivered, but during the last week nearly all of the sales in the domestic market took place at 10c. The market appeared to firm up a little just before the close.

The export price was lowered to 10.30c. c.i.f. on March 12, and, as soon as the moderate offerings on this basis were disposed of, the price advanced to 10.55c. The higher figure was named before the close of business on that day and prevailed throughout the remainder of the period. Export sales during the first half of March amounted to about 10,000 long tons.

The February statistics, in the main, were favorable.

Lead Down 10 Points

Influenced by the unexpected weakness in copper, buying of lead fell off sharply. In an effort to stimulate business, domestic producers announced a 10-point reduction in the price on March 10. This established the market at 4.50c., New York, also the contract basis of the American Smelting & Refining Company, and at 4.25c., St. Louis. The New York quotation is back to the low for the year, with St. Louis 5 points under the recent low because of the greater spread now obtaining between the New York and St. Louis markets. Demand at the lower prices showed no improvement.

Zinc Dull at 4c.

Sales of zinc were few and far between, but the price held on an even basis throughout the period. Virtually all sellers quoted 4c. per pound for Prime Western, St. Louis, with the undertone about steady. Sales were reported at 4c. for April-May-June shipment. Shipments of zinc are slowly increasing, and, with production curtailed, the statistical position is expected to show further improvement.

Tin Steady

Tin was slightly higher. The professional element in London favored the long side, in view of the developments in connection with the tin agreement. However, the weakness in other metals took some of the bullishness out of the market. Quite some work remains to be done on the restriction scheme, but the feeling is general that the plan will go through along the lines announced recently. Trading here has been quiet, as most consumers are well covered.

Silver Advances

The market for silver developed a strong undertone on a sudden change in sentiment growing out of the more favorable political situation in India and a moderate increase in business in China. Offerings were light throughout the period and shorts were badly squeezed. The price touched 31⅜c. per ounce in New York on March 16, a new high for the year. A moderate decline took place on the two succeeding days, a natural development considering the extent of the advance. The net gain in price for the two weeks' period was 3¾c. The undertone of the market was firm on the last day of the period.

United States production of silver during February totaled 3,274,000 oz., according to the American Bureau of Metal Statistics, against 3,480,000 oz. in January, and 3,713,000 oz. in December. Canadian production for February was 1,772,000 oz., against 1,932,000 oz. in the preceding month, and 2,043,000 oz. in December. Mexican production for either January or February has not yet been announced. Peru produced 1,022,000 oz. in February, against 918,000 oz. in January. Australia is credited with an output of 634,000 oz. for February, against 695,000 oz. in January.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £85, less 2 per cent, per long ton, for 98 per cent ingots and bars.

ANTIMONY—Per lb., duty paid, Chinese, spot, 7.25c.; futures, 7.25c. Cookson's "C" grade, spot, 12c. "CMC." grade, 99.9 per cent, spot, 11c. London, Chinese, spot, £25 per long ton.

BISMUTH—Per lb., in ton lots, $1.40. London, 5s. 6d.

CADMIUM—Per lb., 55c. Average price for February was 55c. London, 1s. 9½d.@1s. 10½d.

CHROMIUM—Per lb., 97@98 per cent grade, 85@90c. per lb. contained chromium, maximum 1 or 2 per cent iron.

COBALT—Per lb., delivered: Metal imported from Belgium in the form of rondelles, 97@99 per cent, spot, $2.50. Discounts on contracts. London, spot, 10s. Nominal.

INDIUM—Per gram, minimum 99 per cent, $14@$15.

IRIDIUM—Per oz., $150 for 98@99 per cent sponge and powder. London, £30.

MAGNESIUM—Per lb., ingots (4x16 in.), 99½ per cent, 48c., in 100-lb. lots or more; 2½- or 3-lb. sticks (1⅜x27 in.), 53c., 100-lb. lots or more. London, 2s. 9d.@3s. for 99 per cent ingots or sticks.

MANGANESE—Per lb., 95@97 per cent, 42c.

MOLYBDENUM—Per lb., in 10- to 50-lb. lots, C.P. powder, $9.50; 97 per cent, $6.50. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb. electrolytic cathodes, 35c.; shot and ingot made from remelted electro, 36c. for single lots of spot metal. London, per long ton, £170@175, as to quantity.

OSMIUM—Per oz., $65@$70. Nominal. London, £16@£16 10s.

PALLADIUM—Per oz., $19@$21. London, £3 10s.@£4.

PLATINUM — Per oz. Official price of leading interest, $30. Cash transactions between dealers and refiners at several dollars less. London quotes £5 10s.@£6.

Colombian crude platinum, basis 85 per cent platinum, average price for February, $23 per oz.

QUICKSILVER—Per 76-lb. flask, $101. Inquiry has improved and sales took place on the higher basis. London, £22 7s. 6d. for spot material.

RADIUM—Per mg. radium content, $50 in lots of 4 grams or more, to $65 for 1 gram; smaller quantities, $70.

Daily Prices of Metals

March	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
5	10.275	26.75	4.60	4.35	4.05
6	10.025	27.20	4.60	4.35	4.05
7	10.025	27.25	4.60	4.35	4.05
9	10.025	27.35	4.60	4.35	4.05
10	9.80	27.125@27.20	4.50	4.25	4.00
11	9.80	27.15	4.50	4.25	4.00
Av'ge	9.992	27.144	4.567	4.317	4.033
12	9.775@10.025	27.15	4.50	4.25	4.00
13	9.775	27.00	4.50	4.25	4.00
14	9.775	26.95	4.50	4.25	4.00
16	9.775	27.15	4.50	4.25	4.00
17	9.775	27.45	4.50	4.25	4.00
18	9.775	27.375	4.50	4.25	4.00
Av'ge	9.796	27.179	4.500	4.250	4.000

Average metal prices for calendar week ended March 7, 1931, are: Copper, 10.192c.; Straits tin, 26.992c.; New York lead, 4.600c.; St. Louis lead, 4.350c.; Zinc, 4.050c.; Silver, 27.688c.

Average metal prices for calendar week ended March 14, 1931, are: Copper, 9.846c.; Straits tin, 27.127c.; New York lead, 4.517c.; St. Louis lead, 4.267c.; Zinc, 4.008c.; Silver, 29.750c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East and Middle West is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

Mar.	Sterling Exchange "Checks"	Silver		Gold, London	Mar.	Sterling Exchange "Checks"	Silver		Gold, London
		New York	London				New York	London	
5	4.85 9/16	27 7/8	13	84s11 1/2d	12	4.85 8/8	29 1/2	13 13/16	84s11 1/2d
6	4.85 1/2	28 1/2	13 5/16	84s11 1/2d	13	4.85 9/16	29 7/8	13 3/4	84s11 1/2d
7	4.85 1/2	28 1/8	13 1/16	....	14	4.85 1/2	30 1/4	14 1/16	.....
9	4.85 7/16	29	13 3/8	84s10 3/4d	16	4.85 1/2	31 3/8	14 1/2	84s11 1/2d
10	4.85 1/2	29 3/4	13 3/8	84s11 1/2d	17	4.85 5/8	30 3/8	14 1/4	84s10 1/2d
11	4.85 1/2	30 1/8	13 15/16	84s11 1/2d	18	4.85 5/8	30 3/8	14 3/16	84s10d

Average for week ended March 11: Silver, 28.896c.; Sterling Exchange, $4.85500.
Average for week ended March 18: Silver, 30.292c.; Sterling Exchange, $4.85573.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command five-sixteenths cent premium.

London

Mar.	Copper Standard		Electrolytic (Bid)	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3M	Spot	3 M
5	45 7/8	46 3/8	49 1/4	121 1/2	123	14 1/8	14 1/4	12 13/16	13 5/16
6	46	46 9/16	49 1/4	122 1/2	124	14 1/8	14 5/16	12 13/16	13 3/8
9	45 7/16	46	48 1/2	123 1/4	124 3/8	13 7/8	14 1/8	12 5/8	13 3/16
10	44 11/16	45 1/4	48	122 1/2	123 3/8	13 1/2	13 13/16	12 3/8	12 7/8
11	44 13/16	45 3/8	48	122 1/2	123 3/8	13 7/16	13 11/16	12 1/4	12 3/4
12	45 1/8	45 3/4	48	122 1/2	123 5/8	13 1/4	13 5/8	12 3/16	12 11/16
13	45 1/16	45 9/16	47 1/2	121 3/8	123	13 1/8	13 1/2	12 1/16	12 9/16
16	44 13/16	45 1/4	47 1/2	121 3/8	122 7/8	13 1/16	13 5/16	12 1/8	12 5/8
17	44 13/16	45 5/16	47 1/2	123	124 1/2	13 1/16	13 5/16	12 3/16	12 11/16
18	44 9/16	45 1/16	47 1/2	123 1/8	124 3/8	13	13 1/4	12 1/16	12 9/16

Prices for lead and zinc are the official price for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

RHODIUM—Per oz., $55. Nominal.

RUTHENIUM—Per oz., $50. Nominal. London, £9@£9½.

SELENIUM—Per lb., $1.80@$2, depending on quantity, for black, powdered, 99.5 per cent pure. London, 7s. 8d.@7s. 9d.

SILICON—Per lb., minimum 97 per cent Si, maximum 1 per cent Fe, 15@17c.

TANTALUM—Per kilo, $91 for C.P. bar or sheet.

TELLURIUM—Per lb., $2. London, 10s.

THALLIUM—Per lb., $12.50@$15.

TITANIUM—Per lb. in 50- to 100-lb. lots, 75 per cent, $5.

TUNGSTEN—Per lb. contained tungsten, 98 per cent, powdered, $1.65. London, 2s. 3d.

Metallic Ores

Prices in tons of 2,000 lb., or in "units" of 20 lb., unless otherwise stated.

ANTIMONY ORE—No sales reported. London, per long ton unit, 3s. 9d.@4s. for 60 per cent sulphide ore.

BERYLLIUM ORE—Per unit of BeO, minimum 11 per cent BeO, $4@$5, f.o.b. mines. Per lb. BeO contained, 30c., c.i.f. European ports. Prices nominal.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $19 for 46@48 per cent Cr_2O_3 ore, and $23.50@$24 for 50@51 per cent ore. London, 77s. 6d. for 48 per cent Rhodesian, and 80s.@92s. 6d. for Indian and New Caledonian, according to quality.

IRON ORE—Per long ton, Lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Eastern ores, cents per unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 10c.

Foreign ores, alongside docks Atlantic ports, cargo lots, cents per unit:

North African and Swedish, low-phosphorus, 9@10c.

Spanish and North African basic. 50@60 per cent, 9c.

Swedish foundry or basic, 65@68 per cent, 9½c.

Newfoundland foundry, 55 per cent iron, 9c. Nominal.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, cargo lots, exclusive of duty: Brazilian, 46@48 per cent Mn, 25c.; Chilean, 47 per cent minimum, 29c.; Indian, 48@50 per cent, 26@27c.; Caucasian, 52@55 per cent, 26@27c.; South African, 52@54 per cent, 25@26c., nominal.

Per ton in carload lots:

Chemical grades, powdered, coarse or fine, minimum 80 per cent MnO_2, Brazilian or Cuban, $60. Javan or Caucasian, 85 per cent minimum, $60. Domestic, 70 to 72 per cent, $60, f.o.b. mines.

MOLYBDENUM ORE—Per lb. of contained MoS_2, nominally 45c., delivered Pittsburgh. London, per long ton unit, nominal at 31s. 6d.@35s. for 80@85 per cent concentrate.

TANTALUM ORE—Per lb. Ta_2O_5, 70c. for 60 per cent ore. Market nominal. European bids around 40c.

TIN ORE — No market in United States. London, returning charge on 60 per cent Bolivian, £9@£10 per long ton; on 70 per cent Nigerian, £6 17s. 6d., basis £200.

TITANIUM ORE — Per gross ton, ilmenite, 45@52 per cent TiO_2, f.o.b. Atlantic seaboard, $10@$12, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7 @$8. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c.

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Chinese wolframite, $11.25, duty paid. Bolivian scheelite, $11.50, and domestic, $12.

VANADIUM ORE—Per lb. V_2O_5 contained, 26@28c., f.o.b. shipping point. London, 16 to 18 per cent V_2O_5, nominal at 50s.@52s. 6d. per long ton unit, c.i.f., on contract.

ZIRCON ORE — Per ton, 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots. Crude granular zircon, $70, f.o.b. Suspension Bridge, N. Y.; milled, $90.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

Tons of 2,000 lb., unless otherwise noted.

AMBLYGONITE — Per ton, f.o.b. mines, 8@9 per cent Li_2O, $50@$60.

ASBESTOS — Per ton, f.o.b. Quebec mines, tax and bags included: Crude No. 1, $250@$300; crude No. 2, $200@ $250; spinning fibers, $125@$175; magnesia and compressed sheet fibers, $100@$125; various grades shingle stock, $45@$65; various grades paper stock, $27.50@$35; cement stock, $15@ $20; floats, $10@$12. Market dull and prices largely nominal.

Per ton c.i.f. New York: Rhodesian crude No. 1, $300; No. 2, $200. Nominal.

Per ton, c.i.f. New York: Russian crude, No. 1, $210; No. 2, $150; No. 3, $100.

BARIUM CARBONATE (Witherite) — Per ton, 90 per cent, 200 mesh, $47; 100 mesh, $44.

BARYTES—F.o.b. mines, bags extra:

Georgia: Barytes ore, crude, $6.50 per long ton.

Missouri: Per ton, water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, minimum 95 per cent $BaSO_4$, less than 1 per cent iron, $6.50; 1 per cent iron and 93 per cent $BaSO_4$, $6, f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $6.50@$8, f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6@$7.50, f.o.b. *Arkansas* mines. Pulverized and dried, 56 to 59 per cent Al_2O_3, 8 to 12 per cent SiO_2, $10@ $12.25, f.o.b. *Arkansas* mines; abrasive grade, crushed and calcined, 78 to 84 per cent Al_2O_3, $14@$16, f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic ports: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@ $6.50; one dealer reports $7 for material running 52@54 per cent alumina and 1.50 per cent silica; market fair. Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 4 per cent SiO_2, $6@$8; 56 per cent Al_2O_3, 1.50 per cent SiO_2, $7; 58 per cent Al_2O_3, 3@4 per cent SiO_2, $6.50.

BENTONITE—Per ton, f.o.b. Wyoming mines, dried and crushed, in bulk, $8; in bags, $10. F.o.b. Chicago, selected air-floated, $25.

BORAX — Per ton, carload lots, in bags, crystals, $56; granulated, $50; powdered, $57.50; f.o.b. shipping point.

CELESTITE—Per ton in carload lots, 90 per cent $SrSO_4$, finely powdered, $27.

CHINA CLAY (KAOLIN)—Per ton, f.o.b. *South Carolina* mines, crude lump, No. 1, $5; crushed air floated, $8; pulverized, $9.

Florida, washed and crushed, No. 1, $12.50; No. 2, $12.

Imported English, f.o.b. American ports: lump, $17@$21 in bulk.

EMERY—Per ton, f.o.b. *New York*, domestic crude ore, $10. Other American ore, delivered to grinders, per gross ton, $15; Turkish and Naxos ore, $30 @$35. F.o.b. *Pennsylvania*, in 350-lb. kegs, Turkish, Khasia, and Naxos grain emery, 6½c. per lb.; American, 3½c.

FELDSPAR — Per ton, f.o.b. *North Carolina*, 200 mesh, white, $18, in bulk; f.o.b. *Maine*, white, 200 mesh, $19, in bulk. Granular glasspar, f.o.b. *North Carolina*, $10.50 in bulk.

Virginia, No. 1, 325 mesh, $18; 200 mesh, $15@$16; 160 mesh, $14; No. 1 glassmakers', $11.

New Mexico: Crude clean No. 1 potash spar, $4.75; ground, $9.50.

FLUORSPAR — Per ton, f.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $15. Foundry lump, 85-5, $17. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50 in bags or barrels. *Colorado* mines, 82-5, $12.75.

FULLER'S EARTH — Per ton, f.o.b. *Colorado*, $18, various finenesses to minus 90 mesh.

F.o.b. *Georgia* or *Florida*, 30 to 60 mesh, $17; 15 to 30, $16; 200 up, $10; 100 up, $7.

GARNET—Per ton, f.o.b. *New Hampshire* mines: crude or mill run, $40; washed, $125.

New York: Adirondack garnet concentrates, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. mines *Colorado:*

Brilliant black, $33; seconds (mine run), $25.50.

Selected, $30.50, f.o.b. Utah.

GRAPHITE—Per lb., f.o.b. *New York:* Ceylon lump, 6@7½c.; chip, 5@6½c.; dust, 2@3c.; Madagascar flake, 5½@6½c.

No. 1 flake, 8@16c.; fine ground, 3c. upward; amorphous, 3c. upward.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND — Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, crushed rock, *Iowa*, $2.50; *Ohio* and *New York*, $3. Ground, *Ohio*, $4; *Iowa*, $6. Agricultural, $6@$7. Calcined, $6@$9.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

LEPIDOLITE—Per ton, $50@$60 for ordinary grades. Nominal.

LIMESTONE—Per ton, f.o.b. shipping points, depending on location, either lump or crushed, 25c.@$1.75.

Agricultural, $1 up to $6 per ton, as to grade and point of shipment.

MAGNESITE—Per ton, f.o.b. *California* steel mill points, dead-burned, $29. *Washington:* Dead-burned grain magnesite, $22.

MICA—Per ton, f.o.b. *New Mexico*, scrap, white, $21; off color, $18. Punch, white, for disks, per lb., 10c.; for washers, 8c.

Per ton, f.o.b. *New Hampshire*, roofing mica, $23; snow, $34; 40 mesh white, $40; 60 mesh, $48; 100 mesh, $60; 200 mesh, $75. Clean dry mixed bench and mine scrap, $13.

Per lb., f.o.b. *North Carolina*: Punch, 4@5c.; 1½x2 in., 25@35c.; 2x2, 45@60c.; 2x3, 85c.@$1; 3x3, $1.40 @$1.60; 3x4, $1.80@$2; 3x5, $2@ $2.25; 4x6, $2.75@$3; 6x8, $3.50@ $3.75; 8x10, $5@$7.50. These prices apply both to No. 1 and No. 2 mica. Black-stained mica takes a discount of 10 to 25 per cent from this schedule. White North Carolina mica, 70 mesh, $60 to $80. Biotite, or black mica, $15 a ton, unground.

MINERAL BLACK—(Graphitic shale) —Per ton, 325 mesh, 75 per cent carbon, $22.50, f.o.b. *Virginia*.

MONAZITE—Per ton, minimum 6 per cent ThO_2, $60.

OCHER — Per ton, f.o.b. *Georgia* mines, $17.50 in sacks; $20 in barrels; second grade, $10. Buff clay, 98 per cent through 325 mesh, $18.

F.o.b. *Virginia,* dark yellow, 300 mesh, 60 per cent ferric oxide, in jute bags, $19.50.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4.

Tennessee, ground lime phosphate, 80 per cent through 300 mesh, 33 per cent P_2O_5, $12.80 per net ton, bags extra.

POTASH—Per ton, contracts:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent	$37.15	$35.55
Sulphate of potash, 90@95 per cent, basis 90 per cent	48.25	46.65
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.80	26.20
Manure salt, 30 per cent	22.15	19.15
Manure salt, 20 per cent	15.65	12.65
Kainit, 14 per cent	12.70	9.70

Prices are delivered to Atlantic ports. Discounts up to 4 per cent for early shipment. Spot prices, $1.25@$1.50 per ton higher than on contract.

PUMICE STONE—Per lb., in barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur, c.i.f. United States ports, guaranteed 48 per cent sulphur, Spanish, 13@13¾c.

[1]QUARTZ ROCK CRYSTALS—For fusing, all sizes, $250 per ton. Prisms for piezo-electrical use, $3 per lb. in small lots. Optical grades command premium.

SILICA—Per ton, water ground and floated, in bags, f.o.b. Illinois: 325 mesh, $16@$40 for 92 to 99½ per cent grades. Dry ground, air-floated, 325 mesh, 92@99½ per cent silica, $14@$30. Market steady. Glass sand, f.o.b. producing plant, $1.25@$5 per ton; molding sand, 50c.@$3.50; blast sand, $1.75@$6.

[1]SPODUMENE — Per ton, $50@$60 depending upon lithium content.

[1]STRONTIANITE — Per ton, lump in carload lots, minimum 90@92 per cent $SrCO_3$, $100.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC — Per ton, carload lots, f.o.b. works, containers included unless otherwise specified:

New Jersey: Soapstone, ground, $10@$12.

New York: Double air-floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

Vermont: 99 per cent through 200 mesh, extra white, bulk basis, $8@$8.50; 97 to 98 per cent through 200 mesh, medium white, $7@$7.50. Packing in paper bags, $1 per ton extra.

Virginia: 200 mesh, $6@$7.75; 325 mesh, $8.75@$10.50.

TRIPOLI — Per ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $15. Double ground through 110 mesh, rose and cream, $17. Air-floated through 200 mesh, rose and cream, $22.50.

Rolled Metals

COPPER — Per lb., sheets, hot-rolled, 19⅞c.; wire, f.o.b. mill, 12c.

LEAD SHEETS — Per lb., full rolled, 7½c.; clipped, 7¾c.

MONEL METAL—Per lb., sheets, full finished, 42c.; rods, hot-rolled, 35c.

MUNTZ METAL—Per lb., rods, 16⅜c.; plates, 19¼c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

NICKEL SILVER — Per lb., sheets, 10 per cent, 24⅝@25c.; 18 per cent, 28⅛@28½c. Wire and rods, 10 per cent, 28⅛c.; 15 per cent, 32⅛c.; 18 per cent, 35⅝c.

PHOSPHOR BRONZE—Per lb., sheets and rods, 5 per cent tin, 31¼c.; wire, 5 per cent, 31¾c.; 10 per cent, 37¼c.

ZINC SHEETS — Per lb., 9½c., f.o.b. works; ribbon, 9c.; 7 per cent discount on orders for 18 tons or more.

Metallic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered, all positions. London, per long ton, £19 for Cornish white. Mexican, high grade, £17 10s.

CALCIUM MOLYBDATE OR MOLYTE—Per lb. of contained Mo, 85c.

COBALT OXIDE—Per lb., black, 70@71 per cent contained Co, $1.75. London 8s. for black; 8s. 10d. for gray.

COPPER SULPHATE (Blue Vitriol)—Per lb., in car lots, 4¼c. for either large or small crystals.

GERMANIUM DIOXIDE—Per gram, in 200- to 300-gram lots, $3.50.

SODIUM NITRATE—Per 100 lb., crude natural, in bags ex vessel, Atlantic ports, $2.05.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $15@$18.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6¼c.; French red seal, in bags, 9⅜c.

ZIRCONIUM DIOXIDE—Per lb. in 100- to 500-lb. lots, 87 per cent ZrO_2, commercial, 50c.

Refractories

CHROME BRICK—Per ton, f.o.b. shipping point, $45. Grecian refractory ore, 37@42 per cent, 40c. per unit.

FIRECLAY BRICK — Per M., first quality, $43, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35@$38.

MAGNESITE — Brick, per ton, f.o.b. works, 9-in. straights, $65. Dead-burned grain, $40, f.o.b. Chester, Pa., or Baltimore.

SILICA BRICK—Per M., *Pennsylvania,* $43; *Alabama,* $50@$51; *Illinois* and *Indiana,* $52.

ZIRKITE—Per lb., powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Alloys

FERROCHROME — Per lb. of contained chromium, 4 to 6 per cent carbon, 65 to 70 per cent chromium, 11c., delivered, on contracts; spot, 11½c. Containing 2 per cent carbon, 67 to 72 per cent chromium, 17½c.; maximum 0.10 per cent carbon, 26c.

FERROMANGANESE — Per gross ton furnace; domestic and foreign, 78@82 per cent, $80@$85, contracts, depending on quantity. Spiegeleisen, 19@21 per cent, $30 for spot carloads.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.

FERROPHOSPHORUS—Per ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50, f.o.b. *Alabama* and *Tennessee.*

FERROSILICON — Per gross ton, delivered, 50 per cent, $83.50; 75 per cent, $130; 14@16 per cent, $39, f.o.b. Niagara Falls, N. Y. Spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton, $150, f.o.b. producer's plant.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.10@$1.15, f.o.b. works.

FERROVANADIUM—Per lb. of V contained, delivered, $3.15@$3.50.

SILICOMANGANESE — Per long ton, carload contracts, delivered, $120 for maximum 2½ per cent carbon; $130 for maximum 1 per cent carbon.

SILICON ZIRCONIUM—Per lb., 47@52 per cent Si, 35@40 per cent Zr, 18@21c.

ZIRCONIUM FERROSILICON—Per gross ton, 12@15 per cent Zr, 39@43 per cent Si. $103.50@$108.50.

Iron, Steel and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $17; basic and No. 2 foundry, $16.50.

STEEL—Per gross ton, base prices, Pittsburgh, billets and slabs, $30; bars, plates, and structural shapes, per 100 lb., $1.65; U. S. Steel has advanced price to $1.70, effective April 1.

COKE—Per ton, Connellsville furnace, $2.40@$2.50. Connellsville foundry, $3.25@$4.85. Byproduct coke, Ohio and Kentucky (Connellsville basis), $5.50; Buffalo and Detroit, $8@$8.50; Birmingham, foundry, $5; furnace, $3.50@$4.50.

[1]Price furnished by Foote Mineral Company, Philadelphia.